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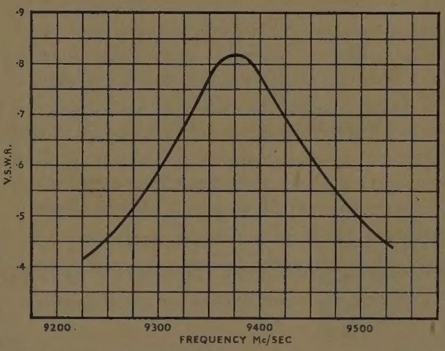

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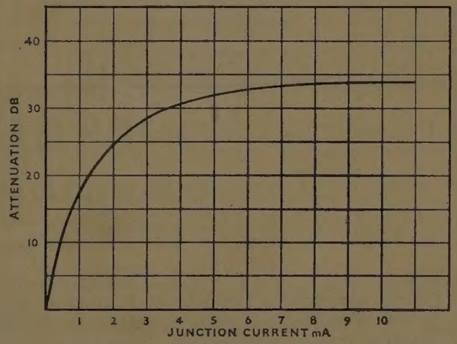

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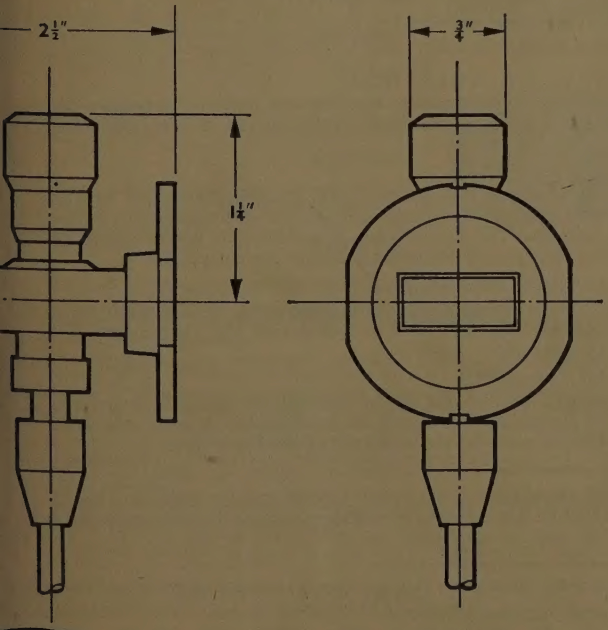

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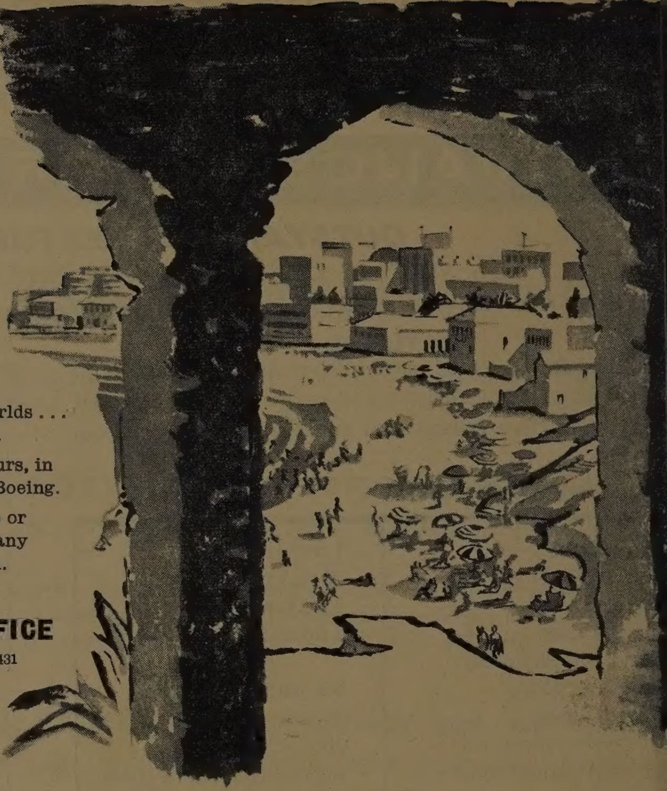

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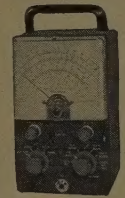
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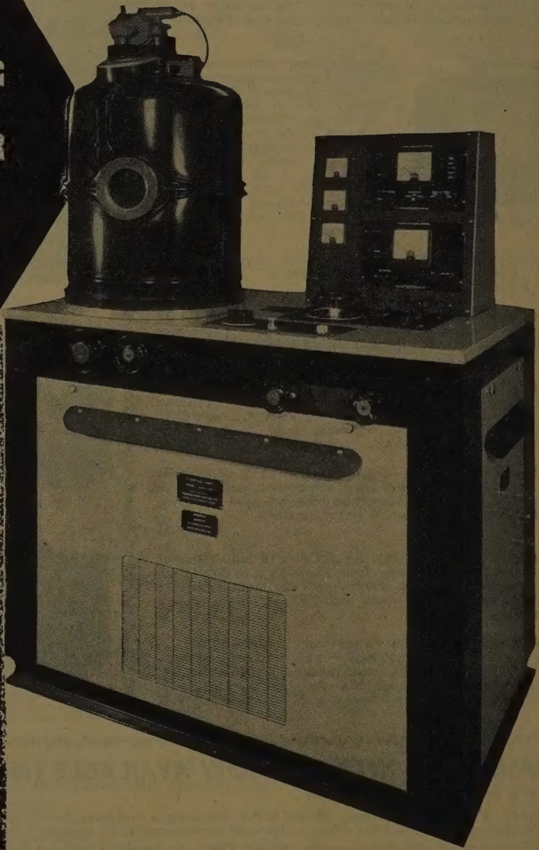

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PHYSICS ABSTRACTS

lume 64 NOVEMBER 1961 Number 767

MATHEMATICS

12730 THE PERTURBATION METHOD DUE TO THE SMALL CHANGE IN THE SHAPE OF THE BOUNDARY.
aito.
Phys. Soc. Japan, Vol. 15, No. 11, 2069-80 (Nov., 1960)
A general method is presented for estimating the effect caused
a small change in the boundary shape (or the hypersurface shape
many-dimensional space, the time-coordinate being included)
n the solutions or eigenvalues of linear partial differential
ations (elliptic, parabolic or hyperbolic). When the given bound-
lightly deformed from a shape favorable for obtaining the
utions, this method gives the approximate solutions or eigen-
ues based upon the exact or unperturbed ones for the case of the
orable shape, where many solutions can be obtained easier. The
owing illustrative examples are given, showing the validity of
method presented: (1) The eigenfrequencies of the lateral
ration of a uniform membrane fixed at its boundary close to a
cle in shape, e.g. elliptic, oval, cinquefoil-shaped, etc. (2) The
envalue problem concerning the heat conduction of a "corned-
f-can" -shaped uniform matter, close to a rectangular parallel-
ped in shape and with its temperature being kept constant on the
ndary surface. (3) Three boundary-value problems representing
parabolic, hyperbolic and elliptic cases, respectively.

12731 DIGITAL COMPUTER WITH PROGRAMMING BY MATHEMATICAL FORMULA. W.Kämmerer.
aer Jahrbuch (Germany), 1959 II, 396-440. In German.
This paper is divided into two parts. In the first part the
ical problems involved in the construction of an 'autocode' are
cussed. In the second part the construction of a machine for which a particularly simple autocode can be used is described. A number of specific examples are given, comparing different methods of programming in some cases. The basic idea underlying the author's approach is that of the 'variable address'. [Rutishauser, Nachrichtentech. Fachber. (Germany), Vol. 4, 26-30 (1956)].

N.L.Johnson

12732 ON THE REALIZATION OF A LINEAR GRAPH GIVEN ITS ALGEBRAIC SPECIFICATION.
L.Auslander and H.M.Trent.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1183-92 (Sept., 1961).

The following problem is discussed: Given an algebraic specification of an oriented linear graph in the form of a branch-mesh or branch-node matrix on any arbitrary basis, how does one proceed systematically to construct the graph? This rather basic problem has been considered by other authors and a few procedures have been described in the literature. On closer examination the problem is not simply one of finding a procedure that will work but rather a question of finding an efficient procedure in terms of the time required by an analyst to carry through the computation. A new procedure is described which is believed to be quite efficient. The method is simple since matrix manipulations are limited primarily to the deletion of rows and columns and the other main manipulation is that of freehand drawing. The procedure is based upon the Decomposition Theorem published earlier [J. Math. Mech. (USA), Vol. 8, 827-36 (1959)] and involves the notion of dividing a large graph into a sequence of small ones. A reassembly process then yields the desired result.

ASTROPHYSICS

2733 ABSTRACTS OF PAPERS PRESENTED AT THE 108th MEETING OF THE AMERICAN ASTRONOMICAL
IETY, JUNE 18-21, 1961, AT THE MARIA MITCHELL
SERVATORY, NANTUCKET, MASSACHUSETTS.
ron. J. (USA), Vol. 66, No. 7, 277-99 (Sept., 1961).

12734 MICROMETER MEASUREMENT OF HIGH DISPERSION SPECTRA. A.D.Petford.
nthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 6, 519-24 (1960).
A position-sensitive Ge photocell was used as the basis of a
ting device for measuring spectra, and has given a great
uction in the time of measurement, and some increase in
cision, compared with visual measurement.

2735 MAGNETOGASDYNAMICS AND PROBLEMS OF COSMOGONY. S.A.Kaplan.
rosy Kosmog, Vol. 6, 238-64 (1958). In Russian, with
lish summary.
In this paper the following basic principles and main results,
ained in magnetogasdynamics, are given: the existence of the
eezing-in" integral, the description of "entanglement" and
entanglement" of the magnetic lines of force, the increase of
gnetic energy in magnetogas shock waves and the concept of
gnetogas turbulence. Some cosmogonic hypotheses based on
thods and results of magnetogasdynamics are discussed: (a) the
nection of spiral arms with the regular magnetic field; (b) the formation of interstellar gas clouds as separate whirl-units of interstellar magnetogas turbulence; (c) the formation of the "halo" of the galaxy as a result of magnetic pressure and that of cosmic rays on the magnetized interstellar gas; (d) the formation of filamentary nebulae as a result of the possible instability of magnetogas shock waves; (e) the origin of stellar magnetic fields in the process of condensation; (f) the acceleration of cosmic ray particles in the interstellar magnetogaseous medium.

Mathematical Reviews

12736 THE RELATIVISTIC MODEL OF THE STEADY-STATE UNIVERSE. W.B.Bonnor.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 5, 475-81 (1960).

It is shown that in the relativistic and Newtonian versions of the steady-state universe the motion of the cosmic matter is indeterminate. The reason is that for matter with equation of state $p + p = 0$, both the inertial and passive gravitational mass densities vanish. The conclusion is that these versions are of doubtful value in the prediction of cosmological observations.

12737 EXPANDING GALACTIC SYSTEMS AND A NEW APPLICATION OF EINSTEIN'S GENERAL THEORY OF RELATIVITY. N.S.Kalitzin.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 1, 41-6 (1961).

A model for a hierarchical universe, in which the density of matter within any unit is so much greater than the average density on the next larger scale that the unit may be treated as though it were in an empty space, is assumed. This model is applied in turn to the multiple galaxies, the superclusters of galaxies, and the metagalaxies. The Hubble effect of the recession of the galaxies in our metagalaxy is obtained, and similar effects are found at the superclusters of galaxies and at the multiple galaxies.

12738 THE K-CORRECTION AND "STEBBINS—WHITFORD" CORRECTION IN RELATIVISTIC COSMOLOGY.

R.Van der Borght.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 177-80 (1961).

An expression for the K-correction and the "Stebbins—Whitford" correction in relativistic cosmology is derived, correct to the the second order in the redshift δ, and with coefficients calculated for the present epoch. The results are then compared with those derived by McVittie [General Relativity and Cosmology. London, Chapman and Hall (1956)] and Davidson (Abstr. 6444 of 1959) and it is shown that, if one works to this order of approximation, the two corrections cannot be completely separated and that a "mixed" correction has to be introduced.

12739 DYNAMICAL CALCULATIONS RELATING TO THE ORIGIN OF THE SOLAR SYSTEM. R.A.Lyttleton.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 6, 551-69 (1960).

The dynamical aspects of certain hypotheses for the formation of planets are shown to be capable of close representation by a restricted 3-body system, and accurate machine integrations of the equations of motion were carried out on such a basis to test the hypotheses. It is first shown that the collisional and tidal mechanisms as applied to the Sun could not result in any particles going into orbital motion outside the Sun at however small a distance. The calculations also show that in a two-body collision of stars only a negligible quantity of material is likely to escape from both stars and be available for capture by the sun; the amount could rise to planetary order only if the relative speed of the colliding stars when widely separated were several hundred km sec^{-1}. Rotational break-up of a companion star to the Sun might fulfil such a condition. The rotational instability of a primitive planet growing gradually from a disk of material in motion round the Sun would probably result in disruption into two main pieces with high mass-ratio and separating with hyperbolic speed. The motion of small particles formed in the stream of material drawn out between the separating main masses can also be investigated by means of a restricted three-body analogy, and in this way it is shown that satellite orbits are possible as a result of the great elongation that the last Jacobi figure possesses together with the high relative velocity of the separating pieces. It is suggested that the rotational stability of the great planets has been reached in this way and by the same means their principal satellites produced. The smaller main pieces resulting from the break-up would have sufficient terminal speed to escape entirely from the solar system.

12740 TESSERAL HARMONICS OF THE GRAVITATIONAL POTENTIAL OF THE EARTH AS DERIVED FROM SATELLITE MOTIONS. Y.Kozai.

Astron. J. (USA), Vol. 66, No. 7, 355-8 (Sept., 1961).

Some constants associated with tesseral harmonics are derived by use of photoreduced Baker—Nunn observations of satellites 1958 $\delta 2$, 1959 $\alpha 1$, and 1959 η. Since the periods of the long-periodic perturbations due to the tesseral harmonics are known, amplitudes and phases of the periodic terms are obtained by the differential orbit improvement programme for each element of each satellite. On the assumption that tesseral harmonics of higher than fourth degree cannot cause any appreciable effect on the satellite motion, constants are derived from the observed amplitudes and phases, and are given in a table.

12741 ON TIDAL TORQUE AND ECCENTRICITY OF A SATELLITE'S ORBIT. G.W.Groves.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 5, 497-502 (1960).

It has long been known, by a simple and general argument, that tidal dissipation within the Earth must slow its rotation, slow the Moon's orbital motion and increase the Moon's mean distance. A hypothesis is made whereby it can be shown, under almost as general conditions, that tidal dissipation must also increase the eccentricity of the Moon's orbit. The exact rate of increase is not determined. However, it is shown that if the Moon were at one time quite close to the Earth the eccentricity would have been at most about 2×10^{-6}; i.e., the orbit would have been nearly circular. This agrees nicely with Darwin's idea (1911) that the Moon originated near the Earth. At the stage where, according to Darwin, the Earth and Moon each present the same face toward each other an revolve with a period of 55 present days, the eccentricity will be about 0.2 to 0.4.

12742 ATTACHMENT PROCESSES IN METEOR TRAILS.

J.S.Greenhow and J.E.Hall.
J. atmos. terrest. Phys. (GB), Vol. 21, No. 4, 261-71 (July, 1961)

The effects of the loss of electrons by attachment to neutral particles on the characteristics of long-duration meteor echoes a considered. In a previous paper some properties of enduring ech were explained using a two-body attachment process, with an attachment time constant of 40 sec at a height of 95 km. This mechanism does not explain satisfactorily the rapid fall off in ech duration below 95 km, and in this paper the effects of two-body an three-body attachment processes are compared. It is concluded that a three-body reaction with a time constant of 70 sec at 95 km gives a better explanation of the rapid decay in electron density a lower heights. This view is supported by the very short duration of visual meteor trains between altitudes of 80 and 90 km.

12743 STONY METEORITE ORBITS.

J.A.Wood.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 1, 79-88 (1961

The observed distribution of apparent radiants and diurnal variation in frequency of meteorite falls, taken together, are show to be consistent only with a bombardment of the earth by fast meteorites (velocity of approach, independent of acceleration by the earth's gravitational field, approximately 8 km/s). This lend support to the traditional view that meteorites pursue asteroid-like orbits before being captured by the earth.

12744 RADIATION AGES OF CHONDRITES.

J.Geiss, H.Oeschger and P.Signer.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 1016-17 (Nov., 1960

He^3/H^3, He^4 and A/K ages are given for eight chondrites and are shown to fall into two well defined groups; one group appear to have been produced in a single break-up process approximatel 22 million years ago, whereas there is reason to think the other group have lost rare gases since their creation and consequently the date of their creaction is uncertain. It is suggested that the He^3/H^3 ratio gives a more reliable estimate of radiation age than the value of He^3 alone. J.M.Ho

12745 OBSERVATIONS OF THE ZODIACAL LIGHT FROM A VERY HIGH ALTITUDE STATION. I. THE AVERAG ZODIACAL LIGHT. D.E.Blackwell and M.F.Ingham.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 113-27 (196

Presents measurements of the absolute surface brightness a three wavelengths, the polarization at two wavelengths and the position of the zodiacal light made from the high altitude station Chacaltaya in the Bolivian Andes (height 17 100 ft, geomagnetic latitude 3°S). This site is particularly suited to such observation because the weather is good and the atmospheric extinction is clo to that expected for a dust-free Rayleigh scattering atmosphere. The brightness and polarization measures extend to within 19° of the Sun. The colour is close to that of the Sun, but it is slightly more red; the polarization measures agree well with those recen obtained by Elsässer [Die Sterne, Vol. 9-10, 166 (1958)].

12746 OBSERVATIONS OF THE ZODIACAL LIGHT FROM A VERY HIGH ALTITUDE STATION. II. ELECTRON DENSITIES IN INTERPLANETARY SPACE.

D.E.Blackwell and M.F.Ingham.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 129-41 (19

The evidence for and against the existence of an interplaneta gas is reviewed. Spectra of the zodiacal light obtained in 1958 wi a dispersion of 38 A/mm are described and used to investigate th concentration of free electrons in the plane of the ecliptic at 1 A from the Sun. No electrons could be detected along a line of sigh at elongation 32° and it is deduced that the electron density 1 A is not greater than 120 cm^{-3}.

12747 OBSERVATIONS OF THE ZODIACAL LIGHT FROM A VERY HIGH ALTITUDE STATION. III. THE DISTUR ZODIACAL LIGHT AND CORPUSCULAR RADIATION.

D.E.Blackwell and M.F.Ingham.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 143-55 (19

Photometric observations of the zodiacal light show that ther are changes in brightness which are correlated with geomagnetic activity. The changes in the zodiacal light and the surrounding s during the intense magnetic storm of 1958 July 8-9 are describe The increase in sky brightness that was then observed is tentativ ascribed to scattering by free electrons in a corpuscular stream e electron density in the stream being about 300 cm^{-3}. There was so a corresponding increase in zodiacal light brightness; the pothesis that this may be attributed to fluorescence of the inter- ınetary dust on impact with the protons of this corpuscular stream examined, but found to be inadequate.

12748 OBSERVATIONS OF THE ZODIACAL LIGHT FROM A VERY HIGH ALTITUDE STATION. IV. THE NATURE ND DISTRIBUTION OF THE INTERPLANETARY DUST.

F.Ingham.

onthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 157-75 (1961).

The problem of the separation of the K-(electron) and F-(dust) mponents of the corona is reconsidered in the light of the revised lue of the interplanetary electron density at 1 A derived in Pt II. method of separation is developed in which it is not necessary to sume that the polarization of the F-corona is zero, but instead a odel of the electron density is assumed. A model of the surface ightness and polarization of the corona and the zodiacal light is nstructed on the basis of existing observations and the method of paration applied to it. The results are compared with theoretical pressions for the surface brightness of the light scattered by lid particles by (a) diffraction and (b) reflection and refraction. lues of the albedo, mass density and number density of the rticles composing the zodiacal cloud are derived. The theory es not, however, account for the observed reddening of the corona.

12749 SOLAR INTENSITY AND LIMB DARKENING BETWEEN 8.6 AND 13 μ. F.Saiedy.

onthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 5, 483-95 (1960).

The intensities of the centre of the solar disk at 8.63 μ and .02 μ were measured by a technique previously described for .10 μ. The emission temperatures obtained were 5160°K at 63 μ and 5050°K at 12.02 μ against the earlier value of 5036°K at .10 μ. The results are a few % greater than values calculated om model solar atmospheres. Limb darkening measurements were ade out to 0.91 of the solar radius (solar image diameter 17 mm) 8.63, 11.10, 12.02 and 12.95 μ, and are in good agreement with ose of Pierce et al. (1950) at 8.3 and 10.2 μ. The combined easurements of solar intensity and limb darkening were used to udy the wavelength variation of the photospheric opacity. The sults show less variation with wavelength than predicted eoretically. They also indicate that the free—free component of opacity calculated by Chandrasekhar and Breen (Abstr. 1414 of 47) is 40% too high, which is approximately in agreement with e recent calculations of T.Ohmura and H.Ohmura.

12750 THE SOLAR RED-SHIFT.

L.A.Higgs.

onthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 5, 421-35 (1960).

The centre-to-limb increase in wavelength of three medium rength iron lines in the solar spectrum was determined, using icrometer measurements of grating spectra. The observations ere made at solar latitudes of approximately ±55°, and at radial stances from the centre between 85 and 100% of the radius of e disk. The limb-effect curve obtained, after corrections for attering of light, is in good agreement with the curve obtained ecently at Oxford (Abstr. 18774 of 1960) for solar equatorial egions. The absolute wavelengths in the solar spectrum of the nes used in this investigation and the vacuum arc wavelengths of e three iron lines were determined using the method of circular annels. The centre red-shifts of the three lines, together with e limb-effect curve, give a red-shift at the extreme limb sub- antially exceeding the shift required by the principle of equiv- ence. It is shown that the line profiles of the solar lines in the ating spectra are affected by the apparatus function of the ectrograph. Allowing for this, the solar lines at the centre peared to be symmetric but an unexplained asymmetry at the treme limb was discovered. This indicates that wavelength easurements alone are insufficient for a determination of the ture of limb effect.

12751 PHOTOELECTRIC PHOTOMETRY OF THE SOLAR CORONA DURING THE ECLIPSE OF 15 FEBRUARY 61.

R.Dumont and M.Rousseau.

R. Acad. Sci. (France), Vol. 252, No. 18, 2675-7 (May 3, 1961).
French.

Relative intensities of the coronal radiation between 5650 and 00 A, and from 1.33 to 2.58 solar radii, were measured with a otomultiplier photometer attached to the 60 cm telescope of the ute Provence Observatory. Tabulations are given of intensity lues measured along a parallel of declination equal to that of the ntre of the sun. D.R.Barber

12752 SPECTRA OF A BRIGHT CORONAL PROMINENCE ASSOCIATED WITH A CLASS 3 FLARE.

I.Elliott, M.A.Ellison and J.H.Reid.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 5, 463-9 (1960).

Photographs and spectra are described of a prominence which formed in the corona following a Class 3 flare at the limb. Line profiles were obtained which are Gaussian in shape. On the assumption that the line broadening is of purely thermal origin a kinetic temperature ~10^5 °K is indicated for the Hα line. The line-widths of H and K require temperatures ~10^6 °K. It is concluded that these great line-widths must arise largely from non-thermal processes occurring within the prominence. Some possible mechanisms are discussed.

12753 VISCOUS DAMPING OF HYDROMAGNETIC WAVES IN THE CORONA. B.C.Landseer-Jones.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 89-93 (1961).

It is suggested that the heat lost by the corona is made good by energy given up in the viscous damping of hydromagnetic waves originating in the chromosphere. An estimate of the energy which the waves, generated by turbulent motion, would carry gives a value of 10^5 erg cm^{-2} sec^{-1}. A frequency for the waves of 10^{-2} sec^{-1}, which seems to be the lowest possible, gives a fall in amplitude by 1/e in 10^{10} cm at a temperature of 10^6 °K. At higher frequencies, the distance for the same fall would be less. The damping is found to be less the smaller the inclination of the wave-normal to the magnetic field. For a dipole type solar field, less energy would therefore be given to the corona over the poles than over the equator.

12754 SOLAR FLARE TRITIUM IN A RECOVERED SATELLITE. E.L.Fireman, J.DeFelice and D.Tilles.

Phys. Rev. (USA), Vol. 123, No. 6, 1935-6 (Sept. 15, 1961).

Tritium and A^{37} were measured in samples of the Discoverer XVII satellite. The tritium content was unusually high, the maximum value being 163 ± 2 tritium decays kg^{-1} min^{-1}. The ratio of tritium to A^{37} atoms was 2500 ± 300 in an iron sample and larger than 9000 in a lead sample. The tritium activity decreased rapidly with depth. The tritium content is too large by a factor of more than one hundred to be explained by nuclear interactions induced by incident protons or alpha particles. The tritium must result from a flux of incident tritons stopped in the material.

EMISSION OF CARBON GROUP HEAVY NUCLEI FROM A 3^+ SOLAR FLARE. See Abstr. 12134

12755 A DISCUSSION ON PROBLEMS OF STELLAR EVOLUTION.

Proc. Roy. Soc. A (GB), Vol. 260, 147-204 (Feb. 21, 1961).

The discussion was held on March 3, 1960 under the leadership of F.Hoyle. See suceeding abstracts for details of the papers presented.

12756 STAR FORMATION — A GENERAL SURVEY.

F.D.Kahn.

Proc. Roy. Soc. A (GB), Vol. 260, 147-51 (Feb. 21, 1961).

12757 STAR FORMATION WITH SPECIAL REFERENCE TO STELLAR CLUSTERS. W.H.McCrea.

Proc. Roy. Soc. A (GB), Vol. 260, 152-9 (Feb. 21, 1961).

Deals with the processes of star formation under existing conditions in the galaxy. The raw material is that of interstellar clouds and attention is called to the inference that this material is probably mainly in the form of molecular hydrogen throughout most of the processes considered. It is found that a cloud having a mass of about 1000 solar masses may well be brought to the point of gravitational collapse by the pressure exerted by "hot" interstellar material, but there is no known agency that is capable of causing a much smaller mass of the raw material to collapse. It is inferred that the material destined to form an entire galactic stellar cluster undergoes gravitational contraction as a whole. This leads to particular instances of the well-known problems in cosmogony of fragmentation and of the disposal of angular momentum. It is suggested that these problems, and others, find a natural solution if the raw material at a suitable stage may be regarded as broken up into "floccules" in a state of chaotic supersonic motion. Then a condensation is formed simply from floccules that happen to be moving towards it. Thus conditions suitable for the production of any star exist only as conditions for the production of a number of stars, this being probably the fundamental reason for the cluster-origin of stars. These ideas have been found to offer what appears to be a promising theory of the origin of the solar system. Finally, reasons are briefly stated for the possible validity of the adopted representation of the state of motion of the medium by the concept of floccules.

12758 A SURVEY OF STELLAR MAGNETIC PROBLEMS AND OF THE MIXING OF MATERIAL IN STARS. P.A.Sweet.
Proc. Roy. Soc. A (GB), Vol. 260. 160-70 (Feb. 21, 1961).

12759 NUCLEAR REACTIONS IN STARS.
T.G.Cowling.
Proc. Roy. Soc. A (GB), Vol. 260, 170-5 (Feb. 21, 1961).

Thermonuclear reactions important for the generation of stellar energy during different phases of stellar evolution are discussed.

12760 THE HERTZSPRUNG-RUSSELL DIAGRAM.
L.Mestel.
Proc. Roy. Soc. A (GB), Vol. 260, 175-82 (Feb. 21, 1961).

12761 EVOLUTION OF STARS DECREASING IN MASS.
A.G.Masevich.
Proc. Roy. Soc. A (GB), Vol. 260, 183-9 (Feb. 21, 1961).

12762 A SURVEY OF OBSERVATIONAL PROBLEMS OF STELLAR EVOLUTION. R.van der R.Woolley.
Proc. Roy. Soc. A (GB), Vol. 260, 189-201 (Feb. 21, 1961).

12763 THE AGE OF THE GALAXY.
F.Hoyle.
Proc. Roy. Soc. A (GB), Vol. 260, 201-4 (Feb. 21, 1961).

Evidence recently obtained from two quite independent sources suggests that the age of our galaxy is at least as great as 1.5×10^{10} years, a value some five times greater than estimates quoted half a decade ago.

12764 VARIABLE STAR OBSERVATIONS OF STANLEY WILLIAMS. R.H.Garstang.
Quart. J. Roy. Astron. Soc. (GB), Vol. 2, No. 1, 24-35 (March, 1961).

Describes the notable contributions to the knowledge of variable stars made by Williams during the early years of the present century, including a reference to his early photographic observations. A useful list of observations made either visually or photographically from 1899 to 1931, and mostly unpublished hitherto, is included.

D.R.Barber

12765 THE INTERPRETATION OF SOME CHANGES IN ORIENTATION OF A BINARY STAR ORBIT.
M.Johnson.
Quart. J. Roy. Astron. Soc., (GB), Vol. 2, No. 1, 9-23 (March, 1961).

A critical review of the problems associated with various types of eclipsing binary systems, with particular reference to the case when the separations between primary and secondary light minima are unequal and undergo a cyclic variation during successive orbital motions so that eclipses occur sometimes before, and sometimes after "mid-period". Discusses also the various items of physical information derivable from both light-curves and spectra of eclipsing binary stars. D.R.Barber

12766 COMPUTING PRECISE STAR CO-ORDINATES.
A.J.Wickens and H.E.Jones.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 4, 399-404 (1960).

The Geodetic Survey of Canada has found it feasible to use a computer to determine precise apparent star co-ordinates without the use of precomputed tables or punch cards of Besselian or Independent Star Numbers and Annual Variation, etc. Corrections for precession, proper motion, nutation, aberration and parallax are applied to the positions from the basic catalogues. Newcomb's precession constants are used; nutation is computed using the formulae of the Improved Lunar Ephemeris; aberration is computed following the method described by Porter and Sadler. The resulting programme requires an average of about ten seconds per star and will preserve the accuracy of FK_3 star co-ordinates for many years from the catalogue epoch.

12767 VISUAL PHOTOMETRIC OBSERVATIONS OF W SERPENTIS. D.B.McLaughlin.
Astron. J. (USA), Vol. 66, No. 7, 351-4 (Sept., 1961).

Observations made from 1928 to 1932 show intrinsic variations with a range of about 0.5 mag. Variations in depths of minima are indicated. Derived normal minima fall between times calculated from O'Connell's and Gaposchkin's formulae.

12768 PHOTOELECTRIC OBSERVATIONS OF SX PHOENICIS.
T.D.Kinman.
Astron. J. (USA), Vol. 66, No. 7, 348-50 (Sept., 1961).

Three-colour photoelectric observations obtained with the 24-inch Victoria refractor of the Cape Observatory in September 1960 are given for the very short period variable SX Phoenici
Although it has been suggested by Wood that both the primary
secondary periods of this star are changing at different rates,
shown that all available observations of SX Phe may be satisfi
constant primary and secondary periods which differ only slig
from those given by Walraven.

12769 UTILIZATION OF A "GRID" OF GREY-BODY MO
FOR DETERMINING THE CHARACTERISTICS OF
STELLAR ATMOSPHERE. L.Houziaux.
C.R. Acad. Sci. (France), Vol. 252, No. 18, 2672-4 (May 3, 19
In French.

Reduced equivalent widths of 10 selected lines observed i
spectra of 4 stars (including the sun) are compared with the s
line-widths calculated from "grey-body" data and published by
de Jager and Neven (1957). Divergences among the tabulated
are attributed to differences in the model parameters. Althou
the material is too sparse to draw general conclusions, it app
unsound to attempt a precise determination of stellar tempera
and surface gravity using a single "grey-body" model.

D.R.B

12770 A NOTE ON THE PROBLEM OF INTRODUCING SPHERICITY CORRECTION TO CONSERVATIVE SCATTERING STELLAR ATMOSPHERE MODEL. K.K.Sen.
Indian J. Phys., Vol. 35, No. 3, 105-10 (March, 1961).

The relative magnitude of the correction to be applied for
curvature in the study of the radiative transfer problem in the
conservative scattering stellar atmosphere is calculated. The
Wick—Chandrasekhar method of solution for the integro-differ
equation of transfer is employed in the first approximation. T
results are shown in a tabular as well as graphical form.

12771 NOTE ON MAGNETIC INSTABILITIES IN STELLA
STRUCTURE. T.G.Cowling.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 4, 393-7 (19

A particular model of a magnetic star, found by Prenderga
(Abstr. 7208 of 1959) to be unstable if the magnetic field is
sufficiently great, is shown to be unstable for all magnitudes o
field. The bearing of this result on the general problem of ma
instabilities is discussed, and it is indicated that such instabili
lead to a readjustment in the field rather than to an explosion
the star as a whole.

12772 THE DRACO SYSTEM, A DWARF GALAXY.
W.Baade and H.H.Swope.
Astron. J. (USA), Vol. 66, No. 7, 300-47 (Sept., 1961).

Draco, a dwarf galaxy similar to the Sculptor system, has
260 variables. The 138 variables in the centre of the cluster w
measured. Of these all but five proved to be RR Lyrae type.
are Bailey's type c, the others are type a. The mean period o
the type a variables is $0^{\mathrm{d}}.613$. Two-thirds of the variables hav
good light curves and the rest show differing amounts of amplit
variation. In the two years observed only two showed actual ch
of period. Of the five variables that are not of the RR Lyrae ty
four have periods between 0.9 and 1.6 days. They are over one
nitude brighter than the RR Lyrae variables whereas variables
corresponding periods in globular clusters are only about $0^{\mathrm{m}}.7$
brighter. No red irregular or long-period variables were found
Draco. The magnitude of the mean intensity in B of the RR Ly
stars is $20^{\mathrm{m}}.48$. This gives a distance of 90 kpsc and a diamete
1380 psc for Draco, if an absolute magnitude of $0^{\mathrm{m}}.5$ is suggeste
the RR Lyrae variables. The colour-magnitude diagram is ass
to globular cluster diagrams, showing that it is an old system
population II. The horizontal branch has few stars on the blue
of the Hertzsprung gap and a strong red branch. The giant bra
at $B-V = 1^{\mathrm{m}}.4$ is $3^{\mathrm{m}}.0$ brighter than the horizontal branch, whic
indicates that the stars of the Draco system are like the halo gl
clusters which are most metal poor. There are some details i
colour-magnitude and luminosity function diagrams that seem t
differentiate it from a typical globular cluster.

12773 AN ANALYSIS OF THE RADIAL VELOCITIES OF GALAXIES IN THE VIRGO CLUSTER. S.van den B
Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 4, 387-91 (1

It is found that the radial velocities in the Virgo cluster do
deviate significantly from a Gaussian distribution. However,
reasonable assumptions regarding the mass to luminosity ratio
galaxies indicate that there is no equipartition of energy betwee
the cluster members. Stable binary and multiple systems appe
exist within the cluster. The velocity differences of members
close pairs may indicate mass to light ratios smaller than thos
obtained from the virial theorem.

774 THE ROTATION OF A BARRED GALAXY UNDER GRAVITATIONAL FORCES. S.Aarseth.
hly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 6, 525-9 (1960).
A simple geometrical model of a barred spiral with central eus is considered. The problem of rotation about an axis nal to the bar axis is discussed, and it is found that a certain ity distribution in the bar will make the system remain stable time of order 3×10^9 years. When the ratio of the diameter e nucleus to the total length of the bar is 1 : 3, this situation ires the ratio of total bar mass to central mass to equal 0.54. e latter is taken to be $5 \times 10^{10} \odot$ the period of rotation is 10^8 years.

2775 NOTE ON THE MAGNETIC STRUCTURE OF THE GALAXY. F.Hoyle and J.G.Ireland.
thly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 1, 35-9 (1961).
The picture of the magnetic field of the Galaxy discussed in ier papers is unsatisfactory in that it does not provide for an low of gas from the galactic nucleus. The observed lack of any rd flow of gas suggests that the interstellar medium must stantly gain angular momentum. But unless the galactic halo is the main reservoir of gas and angular momentum, it is icult to see how this can be the case. It is now suggested that, ead of the spiral arm field being primary and the halo field ondary, as it was in our earlier work, the situation may be ersed. In a model in which lines of force of the halo cross the rarm regions of the galactic plane, it is possible for the whole rstellar medium to gain angular momentum at a comparatively id rate. The windings of the spiral arms then move outwards, eby preventing the arms from becoming more tightly wound time. When the field intensity in the halo is 3×10^{-6} G, the dings move out to the periphery of the Galaxy in a time scale rder 5×10^8 yr. The structure of the spiral arm field, according his new picture, is briefly discussed. It seems that a helical ucture is to be preferred to the usual cylindrical model. A well-wn difficulty concerning the direction of the local spiral arm hen overcome.

12776 CAN GRAVITATIONAL FORCES ALONE ACCOUNT FOR GALAXY FORMATION IN A STEADY STATE IVERSE? M.Harwit.
nthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 1, 47-50 (1961).
Steady-state cosmology requires galaxy formation at the sent epoch. It is shown that, unless matter is preferentially ated in the presence of existing galaxies, a stationary galaxy not gravitationally attract a sufficient amount of matter from the ragalactic medium to double its own mass within a time $T/3$, ere $H = 1/T$ is Hubble's constant. An approximation shows that oving galaxy is also incapable of accreting extragalactic matter his required rate. By summing over the contributions of all axies, it is concluded that gravitational forces alone cannot ng about galaxy formation at the required rate if matter is ated uniformly throughout a steady state universe. If the steady te theory is to survive, it must be postulated that either (1) ation is a markedly localized process, or (2) there exist forces, er than gravity, which can lead to galaxy formation.

adioastronomy

12777 RADIO ASTRONOMY.
K.H.Moore.
s. Today (USA), Vol. 14, No. 4, 20-5 (April, 1961).
Report of a symposium held at Colgate University in April, 1 under the auspices of the New York State Section of the erican Physical Society. The four succeeding abstracts are of icles based on papers presented during the meeting.

12778 CONTRIBUTIONS OF OVERSEAS OBSERVATORIES.
B.F.Burke.
ys. Today (USA), Vol. 14, No. 4, 26-9 (April, 1961).
A survey of activities in radioastronomy in the world outside U.S.

12779 RADIO EMISSION FROM THE PLANET.
F.D.Drake.
ys. Today (USA), Vol. 14, No. 4, 30-4 (April, 1961).
Survey article.

12780 CHARACTERISTICS OF COSMIC RADIO RADIATION.
H.C.Ko.
Phys. Today (USA), Vol. 14, No. 4, 35-9 (April, 1961).
Survey article.

12781 PROJECT OZMA.
F.D.Drake.
Phys. Today (USA), Vol. 14, No. 4, 40-2, 44, 46 (April, 1961).
An account of the experimental programme to detect intelligent transmissions from outside the earth.

12782 THE RADIO TELESCOPE FOR 7.9 METRES WAVELENGTH AT THE MULLARD OBSERVATORY.
C.H.Costain and F.G.Smith.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 4, 405-12 (1960).
This pencil-beam radio telescope, which uses the principle of aperture synthesis, has a resolution of 0.8° × 0.8° at a wavelength of 7.9 m. A survey of the sky between R.A. 05^h and 17^h, Dec. $+10°$ to $+50°$, has proved the performance of the instrument. The map of this region, which is presented in this paper, shows detail of the spur of radio emission at galactic longitude $l' = 0°$; it also shows some discrete sources, including the Coma cluster.

12783 A COMPARISON OF THREE SURVEYS OF RADIO STARS. A.S.Bennett and F.G.Smith.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 1, 71-7 (1961).
The reliability of a recent survey of radio stars using a pencil-beam radio telescope at 178 Mc/s (Leslie 1961) is established by comparison with a high-resolution survey using an interferometer (Scott, Ryle and Hewish 1961). The pencil-beam survey is then used to check the accuracy of surveys by Mills, Slee, and Hill (1958) and by Edge et al. (1959) known as the MSH and 3C surveys, at 85 Mc/s and 158 Mc/s respectively. It is shown that these two surveys are substantially correct for flux densities greater than 20×10^{-26} w.m^{-2} (c/s)$^{-1}$ at 85 Mc/s, and 8×10^{-26} w.m^{-2} (c/s)$^{-1}$ at 159 Mc/s. There is some doubt about the reliability of the MSH survey at lower flux densities, since considerable errors are already found at this level. Some of the extended sources included in the MSH survey appear to represent clusters of unresolved sources.

12784 FIRST RESULTS OF RADIO STAR OBSERVATIONS USING THE METHOD OF APERTURE SYNTHESIS.
P.F.Scott, M.Ryle and A.Hewish.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 2, 95-111 (1961).
Four surveys, centred on declinations of 52°, 50°, 42° and 05° were made at a wave-length of 1.7 m with a large interferometric radio telescope employing the new technique of aperture synthesis. Details of the observational method, calibration, data-reduction and analysis of the computed results are given. An assessment of the performance of the system shows that accurate measurements of the positions and flux densities of radio stars may be extended to limits well beyond those of any previous survey. Lists of sources are given for declinations between 52° and 50° and between 40° and 44°. Observations at 05° were made to study the distribution of radio stars outside the galactic plane; no evidence is found for a population of radio stars in the galactic halo.

12785 RADIO ECHO MEASUREMENTS OF THE ORBITS OF FAINT SPORADIC METEORS. J.G.Davies and J.C.Gill.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 121, No. 5, 437-62 (1960).
A survey was made of the orbits of faint sporadic meteors. The results show that, in addition to meteors moving in orbits similar to those of the comets, there are many in orbits of very short period. The more eccentric of these orbits are concentrated towards the plane of the ecliptic, but some are nearly circular and have inclinations near 60°. The differences between these results and those previously published for bright meteors are discussed, and a qualitative explanation is given in terms of the action on near-parabolic orbits of solar radiation and the major planets.

12786 THE RELATION BETWEEN THE OPTICAL AND RADIO MAGNITUDES OF GALAXIES. R.J.Long and D.R.Marks.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 1, 61-70 (1961).
The first observations with the new large interferometric radio telescope at Cambridge provided positions of good accuracy for several hundred radio sources. Some 200 of these positions were examined on the prints of the 48-inch Sky Survey, and a number of new identifications were made. In addition lower limits were set to the optical magnitude of the objects which are related to the remaining radio sources. The results are combined with those of earlier searches, and are used to derive information on the distribution of intrinsic radio luminosity among the sources. It is con-

cluded that at least 70% of those observed above a given limit of flux density have luminosities greater than 10^{25} w.(c/s)$^{-1}$ ster^{-1} at 178 Mc/s; only about 3% are normal galaxies with a luminosity of 10^{23} w.(c/s)$^{-1}$ ster^{-1} or less.

Space Research

12787 INTERACTIONS OF RAPIDLY MOVING BODIES IN TERRESTIAL ATMOSPHERE. K.P.Chopra.
Rev. mod. Phys. (USA), Vol. 33, No. 2, 153-89 (April, 1961).

A critical survey is given of the various theories of the drag
forces on an artifical satellite of simple shape in a conducti
magnetized fluid, particular attention being paid to non-aero
drag. The effects to be expected in the upper atmosphere a
and data from various Russian satellites used to analyse the
is claimed that all the available estimates of upper atomosp
densities (for heights above 200 km) are untrustworthy and
seriously in error. Some laboratory experiments to disting
between the various theories are proposed. M.R.C.M

TESSERAL HARMONICS OF THE GRAVITATIONAL PO
OF THE EARTH AS DERIVED FROM SATELLITE MOTION
See Abstr. 12740

PHYSICS

GENERAL

12788 PRESCHOOL PHYSICS. F.A.Stahl.
Amer. J. Phys., Vol. 29, No. 9, 579-82 (Sept., 1961).

A programme of physics demonstrations for the nursery school is being developed in which the children themselves participate as active observers. The basis for each presentation is a phenomenon familiar to the child in his own environment, and the approach is to formulate questions for which answers can be found experimentally. To date, lessons have been devoted to magnetism, light, sound, electricity, and the states of matter. The responses and capabilities of the children are in turn being observed, both during the lesson and in associated play immediately afterward.

12789 PHYSICS SUMMER INSTITUTE IN PAKISTAN. E.M.Rogers.
Amer. J. Phys., Vol. 29, No. 10, 661-5 (Oct., 1961).

The writer went to Pakistan, at short notice, in the summer of 1960 to teach in a Summer Institute for college physics teachers there. This article gives an account of the Institute, its 40 "participants" and their needs, and answers one or two questions that a reader would ask.

12790 ON NATURE STUDY IN PHYSICS TEACHING. R.J.Seeger.
Amer. J. Phys., Vol. 29, No. 10, 674-8 (Oct., 1961).

Recommends direct observation and understanding of optical phenomena in nature as a means of stimulating interest of young students in physics. In particular, it urges the collection and utilization of actual photographs. Unsolved problems of meteorological optics are recommended for master's theses not only for their own intrinsic worth, but also as a means of encouraging the modernization field of atmospheric sciences.

12791 CAN FOUR-YEAR COLLEGES PREPARE PHYSICS MAJORS FOR GRADUATE WORK IN PHYSICS?
G.E.Pake.
Amer. J. Phys., Vol. 29, No. 10, 678-84 (Oct., 1961).

Some problems faced by four-year colleges are discussed, together with some proposals for their alleviation.

12792 FUNCTIONAL DEPENDENCE: THREE INTRODUCTORY EXPERIMENTS. A.Romer.
Amer. J. Phys., Vol. 29, No. 9, 630-2 (Sept., 1961).

This paper describes a sequence of three experiments designed to initiate beginners in the particular methods of the physics laboratory. Attention is given to the rules for taking, recording, and analysing data, and for reporting the conclusions drawn from them. The experiments progress from directness and simplicity at the start to a standard level of complexity as the laboratory techniques become more familiar. The sequence is organized around the topic of functional dependence, in each experiment the functional relationship expressed in a particular law of physics being tested by plotting the data in such a form as to give a straight-line graph. The experiments chosen are: (1) the extension of a spiral spring, which gives direct proportion; (2) the acceleration of a ball rolling down an incline, which gives a quadratic function; (3) the simple pendulum, which gives a different approach to the quadratic function, and makes possible the calculation of a known physical constant g.

GRAVITATION . RELATIVIT

12793 GRAVITATIONAL FIELD OF DISTANT ROTATI
MASSES. R.V.Wagh.
Indian J. Phys., Vol. 34, No. 5, 211-16 (May, 1960).

In 1958, Thirring calculated the gravitational field near
centre of a rotating spherical shell. The case can be genera
to that of a rotating mass, where the field away from the ma
be determined. Thirring assumed

$$T^{\mu\nu} = \rho v^{\mu} v^{\nu}.$$

It is shown that, starting from a Galilean field the case of a
Galilean field can be built up by introducing some small ter
metric tensor whose Galilean value is unity. Then by a stra
forward process, $T^{\mu\nu}$ is calculated, given by

$$T^{\mu\nu} = (p_0 + \rho_{00})v^{\mu}v^{\nu} - p_0 g^{\mu\nu}$$

By the introduction of a rotating mass in the galilean field, w
now slightly deviates from its original characteristics, becon
the metric tensor

$$g_{11}, g_{22}, g_{33} = -(1+\alpha)(1, r^2, r^2 \sin^2\theta)$$

and $$g_{44} = (1-\alpha)$$

The energy-momentum tensor is then calculated with $\alpha = m($
$\sin^2\theta\omega^2)$ and it is shown that this satisfies the conditions of m
anics. It is incidentally shown that there is no necessity of i
ducing $E^{\mu\nu}$ in the expression for $T^{\mu\nu}$, as recently done by Ba
Pirani (1955). The desired results are obtained without mak
such assumptions.

12794 SPIN PRECESSION IN CLASSICAL RELATIVISTI
MECHANICS. H.C.Corben.
Nuovo Cimento (Italy), Vol. 20, No. 3, 529-41 (May 1, 1961).

The motion of a point-particle with spin according to rel
istic classical mechanics is shown to possess the following p
ties. A free particle is not required to move along a straight
but may move along a helix in space, or along a hyperbola in
time. The helical motion is the classical analogue of zitterbe
and the hyperbolic motion is the classical analogue of pair pr
tion. The effective mass M of the particle is in general not e
to its rest mass. In a magnetic field B, the particle automat
possesses a magnetic moment $eB\sigma/Mc$, where σ is the spin.
effective mass is a constant of the motion in a uniform electr
magnetic field.

12795 A SEARCH FOR ANISOTROPY OF INERTIAL MA
USING A FULL PRECESSION TECHNIQUE.
R.W.P.Drever.
Phil. Mag. (GB), Vol. 6, 683-7 (May, 1961).

A further attempt was made to detect shifts of the energy
of nuclei in magnetic fields due to anisotropy of inertia arisi
the concentration of matter at the centre of the galaxy (see A
2026 of 1959; 7470 of 1960). A sample containing Li^7 which h
unpaired $p_{3/2}$ proton was used. A nuclear magnetic resonance
experiment was carried out in the Earth's magnetic field bea
sought between the three components of the triplet. It was fo
the level splitting was < 0.04 c/s, corresponding to a ratio of
anisotropic to the isotropic part of the proton neutral mass e
$\sim 5 \times 10^{-23}$. A.A

16 ON THE CANONICAL FORM OF DYNAMICS OF A PARTICLE IN A GRAVITATIONAL FIELD. M.Kohler.
trumKde (Germany), Vol. 68, No. 11, 258-60 (Nov., 1960).
man.

he geodesic equations are written in Hamiltonian form in 4 lent variables, the independent variable being the proper-time particle and the Hamiltonian being $\frac{1}{2}m_0g_{ke}v^kv^l$. Some pro- s of canonical transformations are considered.
C.W.Kilmister

'AN GRAVITATIONAL FORCES ALONE ACCOUNT FOR XY FORMATION IN A STEADY STATE UNIVERSE.
bstr. 12776

'97 THE NORMAL FORM OF A COMPLEX LORENTZ TRANSFORMATION. R.Jost.
phys. Acta (Switzerland), Vol. 33, No. 8, 773-82 (1960).
man.

sing an analysis applicable to any number of dimensions, a ıl form is found for pure imaginary Lorentz transformations. eads to a generalization of the results of Bargmann, Hall and man (Abstr. 2158 of 1958).
W.A.Hepner

798 ON REPRESENTATIONS OF THE NEW FUNDAMENTAL GROUP OF TRANSFORMATIONS IN SPECIAL TIVITY. T.Shibata and M.Ikeda.
Fac. Engng Hiroshima Univ. (Japan), Vol. 1, No. 4, 239-49 h, 1961).

ontinuous linear representations are studied. After deriving mmutator relations between the infinitesimal operators of oup, the form of the matrices which satisfies the relations died. On this basis properties are obtained concerning the sentations of the group. A method is stated for deriving all n-decomposable representations for a given degree.

799 CLOCK RATES AT PERIHELION AND APHELION. B.Hoffmann and W.T.Sproull.
. J. Phys., Vol. 29, No. 9, 640-1 (Sept., 1961).

The difference in distance between earth and sun at perihelion phelion produces a difference in gravitational frequency shift, his is shown to be augmented by the centrifugal effect to give l relative shift of 4.9×10^{-10}. Unfortunately it seems impos- to measure this with any accuracy, since the measurement ves comparing a clock rate now with its rate in 6 months and the necessary external standards involved are broadened ppler shifts.
C.W.Kilmister

RITICAL PERCOLATION PROBABILITIES (BOND PROBLEM).
bstr. 12346

A NEW APPLICATION OF EINSTEIN'S GENERAL THEORY OF ATIVITY. See Abstr. 12737

2800 ON SOME GENERALIZED PLANE WAVE SOLUTIONS OF NON-SYMMETRIC UNIFIED FIELD THEORIES. I-II.
keno.
or (N.S.), Vol. 7, 34-58 (1957); 71-8 (1958).
Mathematical Reviews

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

2801 ON THE LAGRANGIAN SCHEMA IN FIELD THEORY. S.Klarsfeld.
ı. Acad. R. P. Romine, Vol. 8, 159-63 (1958).
oumanian, with Russian and French summaries.

It is shown that, if the Lagrange function

$$L = L(\Psi_A, \Psi_{A,\sigma})$$

quadratic invariant constructed with potentials Ψ_A and their ivatives (corresponding to linear theories), then the symmetri- on of the canonical energy-impulse tensor cannot be obtained change of the Lagrange function according to the formula $= L + \partial_\alpha\Lambda_\alpha$.
Mathematical Reviews

12802 THE LIMITING LAW OF LEVEL SPACINGS FOR A RANDOM MATRIX. M.Gaudin.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 447-58 (June, 1961).
In French.

The distribution function of the level spacings for a random matrix in the limit of large dimensions is expressed by means of a rapidly converging infinite product which was used for a numerical calculation. Comparison with Wigner's hypothesis gives a very good agreement.

12803 TRANSFORMATIONS OF RELATIVISTIC TWO-PARTICLE EQUATIONS. E.Eriksen.
Nuovo Cimento (Italy), Vol. 20, No. 4, 747-58 (May 16, 1961).

It is shown that relativistic two-particle equations like the Breit equation and the Hermitian part of the three-dimensional Bethe—Salpeter equation, in the c.m. system can be transformed to new canonical forms which are generalizations of the Foldy—Wouthuysen—Tani representation and the Cini—Touschek representation, respectively. The expansion of the transformed Hamiltonian is in powers of the inverse momentum. In the case of particles with equal masses also an expansion in powers of the electric charge is made.

12804 ON A PROBLEM OF CONSISTENCY OF THE FIELD QUANTIZATION RULES. Kuo-Hsien-Tzou.
C.R. Acad. Sci. (France), Vol. 252, No. 16, 2382-4 (April 17, 1961).
In French.

Discusses the compatibility of commutation relations with various invariance requirements.
R.J.N.Phillips

12805 CONDITIONS FOR BOUND STATES WITH A GIVEN SET OF INTERACTION POLES IN CHEW—MANDELSTAM THEORY. M.Fowler.
Nuovo Cimento (Italy), Vol. 20, No. 3, 478-86 (May 1, 1961).

Using the potential model with the left-hand cut approximated by n poles, conditions are derived under which no extra "bound state" poles need be introduced. The procedure adopted is to find the domain in n-space convered by the sets of values of residues in which no extra poles need be introduced. It is shown that any point in this domain can be reached by adjusting only n poles on the unphysical sheet.

12806 ON THE PHYSICAL INTERPRETATION OF COMPLEX POLES OF THE S-MATRIX. II. H.M.Nussenzveig.
Nuovo Cimento (Italy), Vol. 20, No. 4, 694-714 (May 16, 1961).

The initial-value problem for a Schrödinger particle interacting with a partially transparent sphere (δ-function potential) is solved by an extension of the method described in Pt I (Abstr. 14520 of 1960). The general solution is expanded in terms of the propagators of transient modes. The relation between this expansion and the stationary-state expansion for an impenetrable sphere is discussed. Two special cases are considered: the decay of a wave packet initially confined within the sphere and the scattering of a wave packet by the sphere in the case of a sharp resonance. In the decay problem, the domain of validity of the exponential law and the deviations from this law are investigated. In the resonance scattering problem, the behaviour of the solution in the internal and external regions as a function of the width of the excitation is discussed. The concept of time delay at resonance is analysed.

12807 A DISCUSSION OF THE NOYES AND WONG EQUATION FOR POTENTIAL SCATTERING.
V.De Alfaro and T.Regge.
Nuovo Cimento (Italy), Vol. 20, No. 5, 956-62 (June 1, 1961).

A discussion is outlined on the Martin form of the Noyes and Wong equation in potential theory. A theorem is given about the connection between zeros of the discontinuity of the S-function and the resonant states.

12808 UNITARITY CONDITIONS IN TERMS OF PROPAGATION KERNELS. E.R.Caianiello and H.Umezawa.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1001-9 (June 1, 1961).

It is shown that, if the group property (macroscopic causality) of the U-matrix is postulated, the proof of its unitarity reduces to a most simple verification on the propagation kernels of the theory. The Appendix gives an explicit proof of that property for electro- and meso-dynamics by means of perturbative expansions, which may be easily generalized.

STATISTICAL MECHANICS
TRANSFER PROCESSES

12809 THEORY OF NON-LINEAR RESPONSES.
O.Nakada.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2280-8 (Dec., 1960).

A phenomenological equation for a nonlinear response to a time-dependent excitation is presented. The response function is expressed as a series of multiple integrals containing the excitation, where the first term corresponds to Boltzmann's linear superposition term. The nonlinearity of an excitation-response system can be characterized, according to the formulation, by higher order after-effect functions. Associated equations including Fourier representations and the inversion formulae are derived. The generalized Kramers—Kronig (1926) relations between the real and imaginary parts of Fourier transforms of higher order after-effect functions are also derived. Applications of the theory to sinusoidal and step function-like excitations, especially with exponential after-effect functions, are discussed in detail.

12810 FORMULATION OF STATISTICAL MECHANICS IN TERMS OF OCCUPATION NUMBERS. I.
R.Balian, C.Bloch and C.De Dominicis.

Nuclear Phys. (Internat.), Vol. 25, No. 4, 529-67 (June, 1961).
In French.

The perturbation expansions of the Gibbs potential and the propagators at finite temperature are put into a new form by means of an algebraic theorem on creation and annihilation operators. The new diagrams are made of subdiagrams having exactly the same structure as the ground state diagrams (the "anomalous" diagrams having disappeared). These subdiagrams play a part analogous to the self-energy insertions in field theory, and their explicit summation can be carried out in a time-dependent formulation. It leads to the replacement in the expansions of the unperturbed statistical factors $f_{\bar{m}}$ by new factors $\mathfrak{F}_{\bar{m}}$ which can be interpreted as the true occupation numbers. A general argument based on the topological structure of the diagrams shows that the expansion thus obtained for the Gibbs potential is stationary with respect to variations of the $\mathfrak{F}_{\bar{m}}$. The formulation presented here leads to an elimination of the activity e^{α}. It appears therefore as a generalization of the classical virial expansion.

12811 CONTRIBUTION TO THE THEORY OF BROWNIAN MOVEMENT IN THE CRITICAL REGION.
I.R.Krichevskii and L.A.Rott.

Dokl. Akad. Nauk. SSSR, Vol. 136, No. 6, 1368-71 (Feb. 21, 1961).
In Russian.

Experiments with dilute solutions of iodine in CO_2 show that near the critical point diffusion virtually comes to a standstill. In the present note it is attempted to account for the experimental result in terms of a random walk theory. Near the critical point fluids break up into droplets of high density which are separated by regions of low density. It is assumed that the probabilities of successive Brownian displacements are not independent if the dissolved molecule moves to a region of different density. From this assumption it is deduced that the overall probability of displacement is drastically diminished. R.Eisenschitz

12812 STATISTICAL THERMODYNAMICS OF MIXTURES. II. CONVERGENCE OF THE QUASI-CHEMICAL METHOD FOR THE ISING SQUARE LATTICE.
S.G.Brush.

J. chem. Phys. (USA), Vol. 34, No. 5, 1852-3 (May, 1961).

For previous part, see Abstr. 3408 of 1959. The critical value of the interaction parameter is calculated, using Guggenheim's method (Abstr. 7245 of 1952), for increasingly large groups of lattice sites. By a machine calculation the work has been extended to all rectangles of sites up to 6 × 6. The extremely poor convergence is illustrated by the fact that the estimate from the 6 × 6 square is 0.488 (compared with the estimate 0.5 from the pair of sites and with the known exact value $\sqrt{2} - 1$). H.N.V.Temperley

12813 ON THE THEORY OF ADIABATIC AND ISOLATED SUSCEPTIBILITIES.
N.Saitô.

J. Phys. Soc. Japan, Vol. 16, No. 4, 621-6 (April, 1961).

A quantum statistical mechanical proof of the equivalence of adiabatic and isolated susceptibilities in large systems is given by Broer's method using a Gibbs relation (Abstr. 8536 of 1951). Further a brief mention is made of the susceptibilities in non-equilibrium cases.

12814 ON THE IRREVERSIBLE BEHAVIOR OF COUPL OSCILLATORS WITH APPLICATION TO TIME FLIGHT.
Y.Kogure.

J. Phys. Soc. Japan, Vol. 16, No. 1, 14-23 (Jan., 1961).

The irreversible behaviour of simple systems is studied A example is a system composed of coupled many harmonic os It is shown that the amplitude of a specified oscillator under appropriate initial condition, and the response function vanis a long time, as the number of oscillators tends to infinity. A example is a system of gaseous particles which is subject to c due to fixed scattering centres. It is shown that if there is o scatterer the occupation number for the initial state changes ically, and if there are many scatterers the occupation numbe exhibits exponential decay.

12815 QUANTUM-MECHANICAL AND SEMICLASSICAL FORMS OF THE DENSITY OPERATOR THEORY RELAXATION.
P.S.Hubbard.

Rev. mod. Phys. (USA), Vol. 33, No. 2, 249-64 (April, 1961).

Shows how both forms of the theory (Abstr. 4631, 8430 o can be derived from a common basis. The theory is used to cuss the behaviour of a system of nuclei with spin $\frac{1}{2}$. The adv tages of the present treatment are described. D.J

12816 ON THE STATE OF A FERMI SYSTEM WITH CORRELATION OF PAIRS OF PARTICLES WITH PARALLEL SPINS. I. GROUND STATE.
Z.Galasiewicz.

Acta phys. Polon. (Poland), Vol. 19, No. 4, 467-76 (1960).

The solution of a compensation equation of dangerous gra for a system of interacting Fermi particles, as an odd function wave vectors is investigated. It is shown that this solution le to an anomalous state the energy of which is smaller than the energy of the normal state. The energy difference is equal to binding energy of the pairs of fermions with parallel spin-mo This anomalous state can exist in the presence of attractive Coulomb interactions. The elementary excitations are separa from the ground state by a gap the width of which depends on direction of the wave vector. For the direction perpendicular the spin direction, energy gap is zero and therefore the state cannot be superconducting. The binding energy of the pairs a the width of the energy gap are of the same order as in the th based on the creation of pairs with antiparallel spin-moments where in the expansion of the interaction term in spherical harmonics, the first coefficient is more than three times grea than the zero coefficient. In the absence of a mangetic field th total spin of the system is zero. In the presence of a magneti field the total spin differs from zero. The paramagnetic susc bility is calculated. See also following abstract.

12817 ON THE STATE OF A FERMI SYSTEM WITH CORRELATION OF PAIRS OF PARTICLES WITH PARALLEL SPINS. II. THERMODYNAMICS.
Z.Galasiewicz

Acta phys. Polon. (Poland), Vol. 19, No. 6, 683-90 (1960).

The thermodynamics of an "anomalous" state of a Fermi system (in which the correlation of pairs of particles with par spins is taken into account) is investigated. The transition ter ature T_c to the "anomalous" state is found, as well as the tem ature dependence of the specific heat for $T \cong 0$ and $T \cong T_c$. A $T = T_c$ the specific heat shows a jump. In addition formulae fo the paramagnetic susceptibilities at $T \cong 0$ and $T \cong T_c$ are obta

12818 SURFACE FREE ENERGY OF A DILUTE GAS.
T.Tsuzuki.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2197-205 (Dec., 1960).

The effect of boundary wall on a dilute gas of hard sphere discussed. The free energy of the system is given as a functio not only of the volume, but also of the surface area of the conta The formula for the excess free energy due to the surface (sur tension) is given both for classical as well as for quantum mechanics. The quantum correction substitutes the effective diameter σ_{eff} for the classical diameter σ of a molecule.

12819 ENTROPY PRODUCTION AND VARIATION PRINC IN THE KINETIC THEORY OF RIGID-SPHERE GA MIXTURE.
T.Murakami.

J. Phys. Soc. Japan, Vol. 16, No. 4, 633-54 (April, 1961).

The balance equations and the fluxes of thermodynamical variables are obtained on the basis of the modified Boltzmann equation for a multicomponent rigid-sphere gas. The kinetic e sion of entropy balance is obtained in terms of the H-theorem, correction to the entropy due to imperfectness of the gas being added. The correction is calculated from the equation of state which is derived from the momentum transport equation. The balance is also formulated thermodynamically with the aid of ibbs relation. By the use of these two expressions a vari- al problem concerning the entropy production rate can be set [he solution of this problem leads to the first approximation :ion for a singlet distribution function, which is identical with og's (1921) apart from the terms independent of the energy pation.

:820 QUANTUM STATISTICS OF SURFACE EFFECT.
T.Tsuzuki.

ıys. Soc. Japan, Vol. 16, No. 3, 377-92 (March, 1961).

The quantum mechanical behaviour of a dilute gas in a vessel a finite volume is considered with special reference to the ıce effect. It is shown that the thermodynamic function of the ɜm with weak interaction between particles can be expanded in ıs of permutation rings with the use of Toda's formula (Abstr. of 1955) and the result is shown to be in harmony with that ved from the method of grand partition functions. An approxi- treatment for molecules with hard cores is also given.

2821 STRUCTURE OF A QUANTIZED VORTEX IN BOSON SYSTEMS.
E.P.Gross.

/o Cimento (Italy), Vol. 20, No. 3, 454-77 (May 1, 1961).

For a system of weakly repelling bosons, a theory of the ıentary line vortex excitations is developed. The vortex state ıaracterized by the presence of a finite fraction of the particles single particle state of integer angular momentum. The radial ndence of the highly occupied state follows from a self-consis- field equation. The radial function and the associated particle sity are essentially constant everywhere except inside a core, re they drop to zero. The core size is the de Broglie wave- th associated with the mean interaction energy per particle. expectation value of the velocity has the radial dependence of a sical vortex. In this Hartree approximation the vorticity is zero ywhere except on the vortex line. When the description of the e is refined to include the zero point oscillations of the phonon d, the vorticity is spread out over the core. These results con- ı in all essentials the intuitive arguments of Onsager and nman. The phonons moving perpendicular to the vortex line are erent excitations of equal and opposite angular momentum rela- to the substratum of moving particles that constitute the tex. The vortex motion resolves the degeneracy of the Bogol- ɔv phonons with respect to the azimuthal quantum number.

2822 SUPERFLUIDITY AND PERTURBATION EXPANSION IN A LARGE FERMI SYSTEM.
A.Tomasini.

ıvo Cimento (Italy), Vol. 20, No. 5, 963-76 (June 1, 1961).

The Bogoljubov—Valatin canonical transformation is performed, ı the perturbation approach for the evaluation of the true states . large Fermi system is examined. It is shown that the difficulty he usual perturbation expansions due to the pole in the ıeckner t matrix is in general overcome by this procedure. It shown that the corrections introduced by the interaction between quasi-particles in the excitation energy are of the same order nagnitude of the excitation energy itself in the region of its ıimum. These corrections appear to be slowly dependent on the ength of the interaction. An approximation is introduced which ın extension of the Brueckner one.

12823 SPECTRUM OF ELEMENTARY EXCITATIONS OF SUPERFLUID FERMI SYSTEMS.

Krush and Ya.V.Tsekhmistrenko.

rayin. fiz. Zh. (USSR), Vol. 4, No. 5, 586-92 (1959). In Ukrainian.

A number of problems involving the spectrum of elementary citations are studied by the methods of quantum field theory. A stem with direct binary interaction is considered at both zero d non-zero temperature, as well as an electron—phonon stem at absolute zero. On finding Schwinger's equations for one- rticle Green functions, use is made of the ground-state approxi- ıtion proposed by Bogoliubov, i .e. a formalism is applied which es not preserve the full number of particles. In all cases, the sults of the investigations agree with those previously obtained ee, for example, Abstr. 8751 of 1950; 1846, 4396 of 1957; 2255, 93 of 1957; 1708 of 1958). The method employed, however, ssesses a greater generality, and differs from the method veloped by Gor'kov (Abstr. 7982 of 1958), which is close to it in inciple, by having a greater heuristic value.

12824 ON THE THEORY OF COLLECTIVE ROTATIONS.
S.Nakai and M.Sasaki.

clear Phys. (Internat.), Vol. 25, No. 2, 333-47 (May, 1961).

An analysis is made of descriptions of collective rotations of ıny-particle systems, in which the emphasis is laid upon the analysis of the flow pattern function generated when the system is set rotating. Some results of recent investigations devoted to the problem of the moment of inertia are also discussed from the present viewpoint. The essential point of the present approach consists in calculating the flow pattern function subject to a constraint. This constraint equation, in simple cases, coincides with that of Tomonaga which was employed to define the canonical momentum describing incompressible deformation. The comparison is made with the work based upon Tomonaga's theory of collective motion. The outcome of the present work will throw light on the method of evaluating the moment of inertia and, in particular, on the question why interactions of the type leading to superfluidity could appreciably change the rigid moment.

12825 THE VIBRATIONAL SPECTRA OF DISORDERED CHAINS.
J.L.Martin.

Proc. Roy. Soc. A (GB), Vol. 260, 139-46 (Feb. 7, 1961).

The dynamical systems discussed here are long chains of particles with randomly distributed masses; both nearest- and next-nearest-neighbour harmonic forces are taken into account. It is shown that in order to find the spectrum of frequencies of vibration the distribution of eigenvalues of a large matrix of special type must be determined, and an accurate and rapid method of computing this distribution is described. By this means the vibrational spectra for several degrees of next-nearest-neighbour interactions are found; they are shown to lend support to a theory relating their main features to similar features in the spectra of almost regular chains possessing defect modes.

12826 DISTRIBUTION OF PARTICLES IN A LOW DENSITY FERMION SYSTEM WITH ATTRACTIVE INTERACTIONS.
Y.Wada.

Progr. theor. Phys. (Japan), Vol. 24, No. 4, 920-2 (Oct., 1960).

It is shown that, if the scattering length of a two-particle system is negative, then a low-density system of such particles must have a distribution, which is drastically changed from that of a degenerate Fermi gas. A.M.Green

QUANTUM STATISTICS OF INTERACTING ELECTRON GAS IN A STRONG MAGNETIC FIELD. See Abstr. 12370

12827 ON THE TRANSPORT EQUATION IN QUANTUM MECHANICS,
L.Blum.

J. Phys. Soc. Japan, Vol. 16, No. 4, 616-20 (April, 1961).

By means of a time-dependent perturbation procedure similar to that developed by Prigogine (Abstr. 10617 of 1960) the transport equation for a particle in a Bose-Einstein medium is obtained. This equation also shows a non-local character.

12828 ON THE APPROACH TO NON-EQUILIBRIUM STATIONARY STATES AND THE THEORY OF TRANSPORT COEFFICIENTS.
R.Balescu.

Physica (Netherlands), Vol. 27, No. 7, 693-706 (July, 1961).

A general formula for the time-dependent electric current arising from a constant electric field is derived along the line of ideas of Kubo's theory. This formula connects the time dependence of the current to the singularities of the resolvent of Liouville's operator of a classical system. It permits direct contact with the general theory of approach to equilibrium developed by Prigogine and his coworkers. It constitutes a framework for a diagram expansion of transport coefficients. A proof of the existence of a stationary state and of its stability (to first order in the field) is given. It is rigorously shown that, whereas the approach to the stationary state is in general governed by complicated non-Markoffian equations, the stationary state itself (and thus the calculation of transport coefficients) is always determined by an asymptotic cross-section. This implies that transport coefficients can always be calculated from a Markoffian Boltzmann-like equation even in situations in which that equation does not describe properly the approach to the stationary state.

12829 INHOMOGENEOUS ATMOSPHERES.
F.M.Hawkins.

Astrophys. J. (USA), Vol. 134, No. 1, 28-44 (July, 1961).

Deals with the case of a finite plane-parallel atmosphere in which there is isotropic scattering at any given optical depth, but the albedo for single scattering is a function $\bar{\omega}(\tau)$ of the optical depth τ. It is shown that, in the case in which $\bar{\omega}(\tau)$ is a step function, the scattering and transmission functions can be found in terms of the X- and Y-functions, and these expressions are given. Thus the expression for the emergent intensity from either boundary of the atmosphere can be written down when the incident radiation is known.

12830 DIFFUSE REFLECTION BY A SEMI-INFINITE ATMOSPHERE. H.G.Horak and S.Chandrasekhar.
Astrophys. J. (USA), Vol. 134, No. 1, 45-56 (July, 1961).

Parallel light of flux density πF_0 is incident on a plane-parallel, semi-infinite atmosphere which scatters light in accordance with the phase function $p(\cos\theta) = \varpi_0 + \omega_1 P_1(\cos\theta) + \varpi_2 P_2(\cos\theta)$. The exact solution for the emergent radiation field is found by using the invariance-principle method.

GENERAL MECHANICS

12831 SELECTED PAPERS ON STRESS ANALYSIS. London: Chapman & Hall; New York: Reinhold Publishing Corporation (1961) 114 pp.

For abstracts of the papers presented at the Institute of Physics Stress Analysis Group Conference, see Abstr. 11718-26, 11732, 11734, 12580-1, 12589 of 1961.

12832 NOTE ON THE DISPLACEMENTS IN A HEAVY VERTICAL CIRCULAR DISK WITH FIXED EDGE AND HAVING AN ISOLATED LOAD AT A POINT INSIDE THE DISK.
S.K.Bhowmick.
Indian J. theor. Phys., Vol. 8, No. 1, 19-22 (March, 1960).

12833 LAWS OF CLASSICAL MOTION: WHAT'S F? WHAT'S m? WHAT'S a? R.Weinstock.
Amer. J. Phys., Vol. 29, No. 10, 698-702 (Oct., 1961).

The basic definitions and laws are systematically developed in a way which, when suitably amplified by the class-room teacher, can be made clearly understandable to any collection of reasonably intelligent beginning students of physics.

12834 MOMENTUM EXPERIMENT FOR THE LABORATORY. A.G.Rouse.
Amer. J. Phys., Vol. 29, No. 9, 635-6 (Sept., 1961).

Describes an arrangement for measuring the force during impact of two trolleys running on a common track. It is then possible to evaluate graphically the integral $\int_0^T F dt$ during the period of impact and compare this with the observed change of momentum. E.G.Knowles

12835 COLLISION EXPERIMENTS IN SHADOW PROJECTION. K. Hecht.
Amer. J. Phys., Vol. 29, No. 9, 636-8 (Sept., 1961).

By using simple pendula with suitable bobs and projecting the shadow of these on to the base of the apparatus, various collision processes may be demonstrated and evaluated quantitatively. Use of the apparatus is suggested for elastic and inelastic collisions, collision of electrically charged bodies, and satellite orbits. E.G.Knowles

12836 SUSPENSION FOR FOUCAULT PENDULUM. Amer. J. Phys., Vol. 29, No. 9, 646 (Sept., 1961).

12837 EQUATION OF MOTION OF THE TORSION PENDULUM AND THE COMPLEX MODULUS. N.W.Tschoegl.
J. appl. Phys. (USA), Vol. 32, No. 9, 1794-5 (Sept., 1961).

Points out an error of Nielsen (Abstr. 9745 of 1951), - which has since been adopted in several publications,- in the differential equation describing the motion of the simple torsion pendulum, operating in free oscillation, in terms of the complex shear modulus. The term missing in the Nielsen's equation is $-k\alpha\eta'\Theta$, where k = a shape constant, α = the attenuation factor, η' = real part of the complex viscosity and Θ = angle of twist. J.K.Skwirzynski

MECHANICAL MEASUREMENTS

12838 A NEW ELECTRO-OPTIC DISTANCE METER WITH AN ACCURACY OF 1 : 10^4.
A.Karolus and J.Helmberger.
Bull. Assoc. Suisse Elect. (Switzerland), Vol. 51, No. 20, 1082-9 (Oct. 8, 1960). In German.

A method for measuring distances of 0·3 to 6·0 km is described. In this method light is modulated sinusoidally and then split into two parts A and B; part A traverses the distance to be measured and then is combined with part B in a phase measuring device. The value of the phase difference is proportional to the distance required. The modulation frequency is 8 Mc/s. Characteristics of Kerr cell and ultrasonic modulators are described. The results of
36 measurements are tabulated; they show deviations of abo
1 part in 5000 and the errors are fully discussed. The poten
of the method are discussed. H.G

12839 NON-DESTRUCTIVE METHOD OF GAUGING E
DEPOSITED NICKEL LAYERS. P.M.Reynolds.
J. sci. Instrum. (GB), Vol. 38, No. 8, 313-17 (Aug., 1961).

An instrument for gauging electrodeposited nickel layer
the thickness range 0.2 mil to at least 1.5 mil is described.
utilizes the local thermal e.m.f.'s set up when a heated metal
is brought into contact with the coating. The final design, n
commercial use, has high stability effected by minimizing te
ature drift in the probe and by selecting materials of approp
thermoelectric properties. The influence of the differing th
electric properties of various commercial nickel deposits u
accuracy of measurement has been evaluated. Extensive in
trials are reported. With subtrates of steel, copper-plated
and copper-plated zinc alloy, amongst 1400 individual meas
of nickel thickness about 90% were within ±0.1 mil.

12840 "VERNI-RAY", AN INSTRUMENT TO MEASURE
UNIFORMITY OF THIN FOILS.
J.Benveniste, A.Mitchell, C.Schrader and J.Zenger.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 927-8 (Aug., 1961).

The instrument uses an alpha source and a solid-state d
in conjunction with a pulse-height analyser, to yield relativel
topographical mappings of the surface density of thin foils to
accuracy of 5 $\mu g/cm^2$.

METHOD FOR DETERMINING COMPARATOR SCREW
WITH PRECISION. See Abstr.12979

12841 RESILIENTLY ISOLATED PRESSURE PICKUP T
RECORD EXPLOSIVE DISTURBANCES. R.G.Ba
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 936-9 (Aug., 1961).

The principle of resilient isolation is employed in the de
of a capacity-type pressure pickup in order to reduce the re
of spurious ringing effects. Continuous operation at high pre
and temperatures is possible. Use of the pickup in engine co
tion studies has shown that the natural frequency of 120 kc/s
sufficient for all but the occasional extremely severe reacti
Frequencies recorded have extended to 430 kc/s.

A POSSIBLE PIEZOMETER FOR THE 100-KILOBAR REGION. See Abstr. 12658

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

12842 NON-NEWTONIAN VISCOSITY AND FLOW BIRE
FRINGENCE OF RIGID PARTICLES: TOBACCO
MOSAIC VIRUS. Jen Tsi Yang.
J. Amer. Chem. Soc., Vol. 83, No. 6, 1316-21 (March 20, 196

The non-Newtonian viscosity and flow birefringence of t
mosaic virus (TMV) were measured over a three-decade ran
of shearing stress, τ. The hydrodynamic lengths, L, as dete
from the two methods were comparable at high τ (after due c
ation of the different averages involved). A striking differen
L, however, was observed as τ approached zero, where the v
curve went through a shallow maximum as contrasted with th
upward curvature for flow birefringence. The concept of equ
valent ellipsoid was found applicable even for "fat" rods like
although its equivalent length could differ by about 15% from
true molecular dimension.

12843 ON THE STEADY MOTION OF AN INDEALIZED
ELASTICO—VISCOUS LIQUID THROUGH CHANN
WITH SUCTION AND INJECTION. S.K.Datta.
J. Phys. Soc. Japan, Vol. 16, No. 4, 794-7 (April, 1961).

The steady flow of a certain type of elastico—viscous liq
in the annulus between two coaxial circular cylinders and be
parallel plane boundaries is considered. It is assumed that
fluid is injected at one boundary and withdrawn at the other,
the same rate, and one of the boundaries is assumed to be mo
with a constant velocity parallel to its generator. Numerical
values are given both for the annulus and for the parallel pla

44 ON THE STRIPE PATTERN DURING ROLLING OF VISCOUS MATERIALS.

ɛ, M.Fukushima and E.Fukada.
's. Soc. Japan, Vol. 15, No. 8, 1708 (Sept., 1960).
regular stripe pattern was observed during rolling of a
ɪr of materials, including butter, printing ink, honey, syrup,
ɛ and silicone oil. The pattern appears on both surfaces of the
ıill, parallel to the direction of rotation. For butter, a family
ves is exhibited relating the stripe separation and viscosity,
fferent values of the clearance between the rolls.

845 LAGRANGIAN ONE-DIMENSIONAL EQUATIONS OF HYDRODYNAMICS FOR A VISCOUS THERMALLY

)UCTING FLUID. D.T.Blackstock.
oust. Soc. Amer., Vol. 33, No. 9, 1245-6 (Sept., 1961).
The exact Lagrangian formulation for one-dimensional,
linear motion of a viscous, thermally conducting fluid is
'ed from the corresponding Eulerian formulation. Applicable
.ts are compared with the Lagrangian equations by Fay (1931)
y Lindsay (1960).

346 THE VELOCITY DISTRIBUTION AT THE INTERFACE BETWEEN TWO LIQUIDS. S.Okuda.

ys. Soc. Japan, Vol. 16, No. 2, 324-8 (Feb., 1961).
3y carrying out detailed experiments in a water flume of
ısions 180 cm × 50 cm × 15 cm observations were made, by
se of a suitable colouring material, of the velocity distribution
the interface between two superposed liquids having different
ties, the lighter liquid flowing over the heavier one confined
ıollow. It was thus found that if there is any difference, how-
small, between the densities of the two liquids, the velocity of
pper liquid decreases fairly rapidly near the interface, as if it
a solid plane, while the lower liquid is almost at rest in the
w. Attempts were then made to explain the observed flow
rn theoretically. First, a rather simple approximate calcula-
vas performed by assuming that the two liquids were in direct
.ct with each other, but no satisfactory explanation of the
rved flow pattern was obtained. An improved calculation was
made by assuming that there was formed a thin intermediate
between the two liquids and it was found that the calculated
pattern is, in this case, in fairly good agreement with the
rved one.

847 FLOW OF CONDENSING VAPOUR WITH TEMPORARY SUPERSATURATED STATE DUE TO HEAT-REMOVAL

ECT. K.Niu.
ıys. Soc. Japan, Vol. 16, No. 4, 798-805 (April, 1961).
The vapour flow in a pipe of constant cross-sectional area
heat-removal effect through the pipe walls has a temporary
rsaturated state in the supersonic flow by an effect of surface
on of the droplets which are born in the vapour. In case when
luid is maintained continually in the supersaturated state, the
of the increase in relative humidity to the increase in Mach
ɔer or to the decrease in pressure is greater in the flow with
-removal than in the adiabatic flow. Numerical calculations
carried out for an example of the flow with definite initial
itions and the region where the condensation shock takes place
edicted theoretically.

848 A SIMPLIFIED METHOD CALCULATING THE LAMINAR BOUNDARY LAYER. S.Kawamata.

ıys. Soc. Japan, Vol. 16, No. 4, 805-7 (April, 1961).
A somewhat simplified method for calculating the steady and
npressible laminar boundary layer flow is developed based on
dea of the "local similarity". The analysis is performed by
g the variables proposed by Goertler [J. Math. Mech. (USA),
6, 1 (1957)]. The calculated results are utilized to predict the
ration points in some decelerated flows and the comparison
other exact solutions shows that the value of the "similar
meter" may be taken as -0.224 at the separation points in this
ıod.

2849 THE CLOSED CONVECTIVE BOUNDARY LAYER.

G.Z.Gershuni and E.M.Zhukhovitskii.
. Akad. Nauk SSSR, Vol. 124, No. 2, 298-300 (Jan.11, 1959).
ussian.
The paper considers the problem of the free convection of
contained within a horizontal circular cylinder, the surface
ɔerature of which varies sinusoidally around the circumference.
suggested that, when the temperature differences are great,
low consists of an inner core behaving like an ideal fluid, surrounded by a thin boundary layer) an idea previously put forward by Batchelor and others for a two-dimensional velocity field). An approximate quantitative solution is given by a Pohlhausen type of method. [English translation in: Soviet Physics—Doklady (USA), Vol. 4, No.1, 102-104 (Aug.7, 1959).] N.Curle

12850 CELLULAR STREAM MOTION IN FLUIDS.

K.Matschat.

Naturwissenschaften (Germany), Vol. 47, No. 22, 507-12 (1960). In German.

Reviews the theory of the motion of fluids in thermally unstable layers and discusses the conditions, principally in terms of the Rayleigh number for the motion, for the formation of cellular structure in stratified layers (Benard cells) and between rotating cylinders. The conditions are also examined which lead to persistence of the cells, as in some types of cloud, and to the kind of motion in which the cells build up to a maximum growth, dissipate and then rebuild afresh. J.M.Stagg

12851 STEADY SPHEROIDAL VORTICES — MORE EXACT SOLUTIONS TO THE NAVIER—STOKES EQUATION.

V.O'Brien.

Quart. appl. Math. (USA), Vol. 19, No. 2, 163-8 (July, 1961).

The vorticity equation, the curl of the Navier—Stokes equation, is considered in ellipsoidal coordinates. The steady spheroidal vortex solutions are demonstrated as examples of a class exact flow solutions characterized by a simple linear vorticity distribution.

12852 ON THE THEORY OF THE PROPAGATION OF PLANE, FINITE AMPLITUDE WAVES IN A DISSIPATIVE FLUID.

W.W.Lester.

J. Acoust. Soc. Amer., Vol. 33, No. 9, 1196-9 (Sept., 1961).

The dissipationless theory for harmonic generation in an initially sinusoidal, plane, finite-amplitude wave is used as a basis for calculation of the harmonic components of such a wave in a fluid with dissipation. The assumption used is shown to lead approximately to the relationships of the Fox and Wallace theory (Abstr. 1621 of 1955). The result is given as a Fourier series, with graphs of the first few harmonic components for two specific cases. The series representation is valid for distances $X \leq L$, where L is the discontinuity distance for the dissipationless case.

INTERNAL WAVES IN THE OCEAN. See Abstr. 12686

12853 SIMPLE METHODS OF DETERMINING WATER DROP SIZES BY MEANS OF PHOTOGRAPHIC EMULSIONS.

L.R.Koenig and P.A.Spyers-Duran.

Rev. sci. Instrum. (USA), Vol. 32, No. 8, 909-13 (Aug., 1961).

Two simple methods of determining the size spectrum of water drops are described. The methods are sensitive to droplets 80 μ or greater in diameter; one has the advantage of requiring no advanced preparation of materials, the other provides a permanent record. The procedures were developed to obtain raindrop size distributions but may be applied equally well to problems concerning drop spectra from spray systems.

RAPID AND CONTINUOUS MEASUREMENT OF RAINDROP SIZE DISTRIBUTIONS. See Abstr. 12687

12854 ROTATING BOWL FOR THE PRODUCTION OF UNIFORM DROPS.

E.N.Brown.

Rev. sci. Instrum. (USA), Vol. 32, No. 8, 914-15 (Aug., 1961).

Describes a drop generator in the form of a rotating Plexiglas bowl which dispenses large quantities of uniform drops (80-400 μ) with excellent selectivity as to drop diameter.

12855 COMPRESSIONAL AND YOUNG'S MODULI IN MONOLAYERS.

N.W.Tschoegl.

J.Colloid Sci. (USA), Vol. 16, No. 1, 89-90 (Feb., 1961).

Reference is made to Cheesman and Sten-Knudsen's method [Biochimica et Biophysica Acta, Vol. 33, 158-63 (1959)] for the determination of the compressional modulus by measuring the displacement of a mica float under a known applied force. The condition of no lateral freedom could probably be achieved with a long rectangular float leaving only negligible gaps between the ends and the trough. Otherwise, a surface compressional modulus should have the dimensions dyne/cm and not dyne/cm^2. R.Schnurmann

12856 MICROBUBBLE PERSISTENCE IN FRESH WATER.
W.R.Turner.

J. Acoust. Soc. Amer., Vol. 33, No. 9, 1223-33 (Sept., 1961).

Preliminary research confirms that microbubbles become stabilized in a body of water and persist for long periods of time in contradiction of classical theory. The evidence was obtained by generating bubbles at the bottom of a water tank and then measuring the decay of ultrasonic attenuation as bubbles of various sizes rose to the surface. Comparison of experimental and classical decay curves disclosed persistence that appeared to be a function of the solid particle content of the water and indicated that bubbles may stabilize at sizes as large as 30μ radius in water of high particulate content. In waters of low particulate content the decay of attenuation lasted over 100 hr. Substantial persistent abnormal attenuation was detected in all fresh tap water measured, amounting to a minimum 44% over that of distilled water (at 5.125 Mc/s) and is believed to be caused by stabilized bubble nuclei somewhat less than 0.8μ in size. An interesting discovery was that attenuation rose in an uncovered test basin but fell in a covered basin, indicating that microbubbles may enter water on dust particles. A hypothesis presented to explain the persistence effect suggests that solid particles collect on the bubble surface, forming a compressed wall capable of supporting the excess pressure necessary to halt gas diffusion. Other hypotheses explore the mechanism by which dust particles may carry air globules below the water surface and the dynamics of microbubble populations.

12857 EFFECT OF MASS TRANSFER ON THE VELOCITY OF RISE OF BUBBLES IN WATER.
J.H.Leonard and G.Houghton.

Nature (GB), Vol. 190, 687-8 (May 20, 1961).

In using the intensity change of light transmission through bubbles rising in water, the mass transfer-rate (i.e. the solubility) together with the velocity of rise, U, and bubble diameter were measured for carbon dioxide, ethylene, nitrogen, and nitrous oxide. It is found that the mass transfer retards U, especially for bubbles of small diameter (2-4 mm). For increasing diameter, U is increasing for the more soluble gases and decreasing for the non-soluble gases. At about 5 mm (and up to 20 mm) U is the same for all gases (around 22 cm/sec). A possible explanation is sought in the electro-kinetic effects caused by the mass transfer, which may induce an electrically charged layer at the bubble surface and thereby increase the skin friction. C.B.Ludwig

12858 SIMILARITY IN BEHAVIOUR BETWEEN GAS BUBBLES IN LIQUID AND FLUIDIZED SOLID SYSTEMS.
P.D.Bloore and J.S.M.Botterill.

Nature (GB) Vol. 190, 250 (April 15, 1961).

Outlines a study, by a γ-ray transmission technique, of void residence times and hence bubble frequencies when a measured gas volume was injected into a fluidized bed of solid particles. At higher gas flow-rates the frequency was approximately constant but below injection rates of 50 $cm^3 sec^{-1}$ a marked tendency existed for this frequency to rise, an effect similar to that reported when air was injected from similar-sized nozzles into water alone.

J.W.Taylor

12859 INERT ENCLOSED PUMP FOR SHAPED FLOW OF ULTRACLEAN SOLUTIONS. M.W.Barnes and R.H.Noyce.

Rev. sci. Instrum. (USA), Vol. 32, No. 3, 353 (March, 1961).

A magnetically driven centrifugal pump fitting through a 2 in. ground-glass joint is described. With a pump-drive magnet separation of 3.5 cm a meniscus was produced on the surface 18 cm above, and 700 $cm^3 min^{-1}$ was circulated at 1200 r.p.m. The pump body was Teflon while the bearings and screw were Nylon. The slinger was a commerically available Teflon-covered magnet.

R.Schnurmann

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

12860 X-RAY INVESTIGATION OF SHORT-RANGE ORDER LIQUID SOLUTIONS OF ZINC IN MERCURY.
D.M.Karlŷkov.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 370-4 (1958). In Ukrainian.

X-ray diffraction was employed to study the structure of solutions with zinc concentrations of 8.7,12.0 and 21.0%. The maxima on the intensity curves occupy an intermediate position between their respective positions in the pure metals. As the zinc concentration increases, a decrease is noted in the height of t first maximum and a shift from its position in pure mercury t position in zinc. The coordinate number increases from 8.4 t An analysis of the diffraction picture leads to the conclusion t liquid zinc amalgams belong to the group of physical solutions

12861 THE STRUCTURE OF SOME METALLIC LIQUID ALLOYS. O.S.Lashko and O.V.Romanova.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 375-84 (1958). In Ukra

Analyses are made of the X-ray diffraction patterns of fus Bi—Sn, Bi—Pb, Sn—Zn and Al—Ag. Monochromatic intensity for scattered X-rays, as well as atomic radial distribution cu were obtained for the eutectic liquid alloys Bi—Sn, Bi—Pb and Sn—Zn, and the binary solution Al—Ag. An analysis of the ato radial distribution curves shows that the liquid eutectic alloys contain small regions consisting solely of A atoms or of B ato The present measurements show that in the Al—Ag alloy there a definite, although slight preference for unlike neighbours in solution.

12862 X-RAY INVESTIGATION OF SHORT-RANGE ORD IN Sn—Bi ALLOYS IN A LIQUID STATE.
Ya.I.Dutchak.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 504-7 (1959). In Ukra

The alloys contained 10 and 20% Bi by weight. As a resu of an analysis of the radial distribution curves, the statistical distribution of the atoms is established. In the case of the all with 10% by weight of Bi, the radius of the first coordination equals 3.22 A, while the coordination number is 9.9. On incre the concentration of Bi in the alloy, the radius of the coordina sphere and the coordination number increase. For the alloy w 20% weight of Bi, they are 3.23 A and 10.2 respectively.

12863 THE STRUCTURE OF MONATOMIC MOLTEN ME BY A NEW METHOD OF ANALYSIS.
H.Richter and G.Breitling.

Z. Naturforsch. (Germany), Vol. 16a, No. 2, 187-202 (Feb., 19 In German.

Neutron, electron and X-ray diffraction patterns of Bi, Sn In, Hg, Au, and Ag are discussed in terms of two statistical m (a) a two dimensional layered structure and (b) a distribution close-packed spheres. Both types of structure are present an former scatter proportional to N^2 where N is the number of scattering centres if the regions are of the order of 10^{-6}cm, regions of the order of 10^{-7}cm scatter proportional to N.

J.E.

STUDY OF LIQUID LEAD USING A NEUTRON BEAM.
See Abstr. 12351

12864 [CONTRIBUTION] TO THE PROBLEM OF THE STRUCTURE OF LIQUID WATER. G.G.Malenkov

Dokl. Acad. Nauk USSR, Vol. 137, No. 6, 1354-5 (April 21, 196 In Russian.

For abstract, see Abstr. 11749 of 1961. [English translat in: Soviet Physics - Doklady (USA), Vol. 6, No. 4, 292-3 (Oct., 1961)].

12865 ON THE THEORY OF THE FRACTURE OF LIQU
H.Wakeshima.

J. Phys. Soc. Japan, Vol. 16, No. 1, 6-14 (Jan., 1961).

The theories of fracture of liquids, those of Temperley's (Abstr. 1747 of 1947), Doring's (1937-8) and Fisher's (Abstr. of 1949) are criticized in comparison with observations mainl Briggs (Abstr. 3913 of 1953). The effect of bubble size on sur tension according to Tolman's theory (Abstr. 3008 of 1949) is taken into consideration for comparison. As the result is not satisfactory, a new hypothesis for the curvature effect is prop which brings about a better agreement of the nucleation theory Briggs' data.

12866 A MODEL THEORY OF LIQUID.
A.Ookawa.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2191-7 (Dec., 1960).

As a structural model of liquid, a crystal threaded by a fi network of dislocations is proposed. The main propositions characterizing the model system are the elastic distortion of t mesh material in bulk rather than the local distortion at the c of the constituent dislocations, the frequency modulation for th transversal shear waves due to the anharmonicity of the potent l the introduction of degenerated non-harmonic shearing trans- ons. With the prepositions, the model system is shown to dis- y a kind of first order phase transition between an imperfect ystal as representative for the liquid phase and a perfect crystal representative for the solid phase. The order of magnitude of the quency modulating coefficient, the only adjustable parameter, is imated under comparison with the experimental data of noble tals.

12867 THE TUNNEL THEORY OF FLUIDS: THE 12:6 FLUID.
J.A.Barker.

oc. Roy. Soc. A (GB), Vol. 259, 442-57 (Jan. 24, 1961).

A theory of fluids is described based on a "tunnel" model, in ich lines of molecules are pictured as moving almost one- nensionally in tunnels or fine capillaries, the walls of the tunnels ing formed by neighbouring lines of molecules. This model is nilar to the cell model in that the whole fluid is broken down into bsystems sufficiently simple to permit explicit calculation of eir properties; in the cell model the subsystems are single mole- les moving in cages, in the tunnel theory they are whole lines of olecules moving in tunnels. The advantages of the tunnel model e that density fluctuations are permitted in a natural way, so that e difficulty of the "communal entropy" is no longer insuperable; d that the basic "structure" is a disordered one, since the mole- les in different tunnels are randomly placed with respect to each her. This model has already been shown to give a good descrip- on of the "hard-sphere" fluid; in this paper it is applied to the :6 fluid and shown to give values for liquid densities, compressi- lities and vapour pressures which are satisfactorily close to the perimental values for simple liquids. The calculated critical nstants are less satisfactory, probably because the approximation treating the motion along the tunnels as one-dimensional is less curate at low densities.

12868 ON THE INTERNAL CONSISTENCY OF THE HYPER-CHAIN APPROXIMATION IN THE THEORY OF LASSICAL FLUIDS.
G.S.Rushbrooke and P.Hutchinson.

hysica (Netherlands), Vol. 27, No. 7, 647-56 (July, 1961).

The hyper-chain approximation in the theory of classical fluids, nd a second approximation in which some account is taken of the rst elementary diagram, are examined for internal consistency y calculating virial expansions of the pressure both directly and om the compressibility equation. Both theories are internally nconsistent at the fourth virial coefficient. Numerical results are resented for both fourth and fifth virial coefficients for a gas of ard spheres, and compared with those given by earlier treatments. brief comment is made on the consistency of the equations for uid mixtures.

INVESTIGATION OF THE DENSITY OF ETHYL ETHER EAR ITS CRITICAL STATE USING γ-RAY ABSORPTION. ee Abstr. 13027

DEPENDENCE OF THE DENSITY OF HEXANE ON THE EMPERATURE IN THE NEIGHBOURHOOD OF THE CRITICAL OINT. See Abstr. 13021

12869 STUDIES OF FUSED SALTS. III. HEATS OF MIXING IN SILVER NITRATE—ALKALI NITRATE MIXTURES.
.J.Kleppa, R.B.Clarke and L.S.Hersh.

. chem. Phys., Vol. 35, No. 1, 175-80 (July, 1961).

For Pt II see J. phys. Chem., Vol. 64, 1937 (1960). The nthalpies of mixing in binary liquid mixtures of silver nitrate with thium-, sodium-, potassium-, and rubidium nitrate were measured. is found that the molar enthalpy of mixing (ΔH^M) changes in a egular fashion from positive values for lithium- and sodium- to egative values for potassium- and rubidium nitrate. Neglecting econd-order effects, the mixing enthalpies may be represented by ne following semiempirical relation,

$$\Delta H^M \cong -X(1-X)\,[140\,\delta^2 - 24\,(\delta - 0.01)]\,\text{kcal/mole.}$$

he parameter δ is $(d_1 - d_2)/(d_1 + d_2)$, where d_1 and d_2 are the nterionic distances characteristic of the two pure components, hile X and (1 − X) are their mole fractions. In this expression the ^{2} term is taken from the equivalent expression for the binary alkali itrates, which presumably are essentially ionic. The value of the umerical factor (140 kcal/mole) is of the order of the lattice energy f these salts. The term which is linear in δ takes into account epartures from ionicity in silver nitrate, and is of magnitude comparable to the nonionic contribution to the lattice energy of this compound. It is shown by considering available e.m.f. data for the silver halide—alkali halide systems that expressions of this type may be quite useful in predicting the heats of mixing in as yet unexplored systems.

12870 THERMAL DIFFUSION FACTOR FOR HYDROGEN AND WATER MIXTURES.
S.C.Saxena.

Indian J. Phys., Vol. 34, No. 10, 449-55 (Oct., 1960).

The thermal diffusion factor for the system hydrogen and water-vapour, has been calculated from an equation which utilizes only the experimental data on transport properties and their temperature derivatives and is independent of any particular form for the inter-molecular potential. The thermal diffusion factor has been computed for other systems which emerge out of the different isotopic species of these two principal components. These values are of particular interest in interpreting the data obtained on the enrichment of hydrogen isotopes, in a thermal diffusion column, using the following chemical exchange reaction:

$$HD + H_2O \rightleftharpoons HDO + H_2 .$$

12871 VISCOSITY OF AN Sn—Bi SYSTEM.
O.Z.Golȳk, N.A.Rȳndȳch and S.A.Babenko.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 365-9 (1959). In Ukrainian

The coefficient of dynamic viscosity was investigated for solutions containing 25, 42 and 60% by weight of Sn in Bi at temperatures ranging from the melting point to 350°C. The viscosity isotherms lack singular points, a deviation towards increase of viscosity (not exceeding the experimental error) being noted only at Sn concentrations of 25%. On the basis of this viscosity data and of previous X-ray investigations and electrical conductivity data, the Sn—Bi system should be regarded as belonging to the group of molecular immiscible solutions. It may be assumed that these systems contain no atom groups in the liquid state which correspond to chemical compounds.

12872 VISCOSITY AND ELECTRICAL CONDUCTIVITY OF ZINC AND CADMIUM AMALGAMS. II.
O.Z.Holȳk and I.F.Klassen.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 491-6 (1959). In Ukrainian.

For Pt I, see Abstr. 6688 of 1958. An investigation was made of the viscosity, density and electrical conductivity over a wide range of temperatures and concentrations. A study of the viscosity confirmed the possibility of obtaining isoviscous solutions in the given system. The temperature dependence of the viscosity of the solution is subject to the exponential law of Frenkel and satisfies Bachinskii's equation. The energy of activation of viscous flow is a linear function of the concentration. Solutions were obtained with coinciding polyterms of specific resistance. A typical feature of such solutions is that there is a strictly definite number of zinc and cadmium atoms for every atom of mercury. The specific resistance of isoviscous solutions varies. The density decreases linearly with a rise in temperature. The densities of the isoviscous solutions vary. In a given system solutions may be selected with density polyterms that practically coincide. The viscosity varies in such solutions, while the specific conductivity differs only slightly. On forming Zn—Hg or Cd—Hg solutions a slight compression is observed, the density of the solutions being less than that predicted by the rule of additivity.

12873 DENSITIES OF SOLUTIONS OF CONDENSED GASES $A-CH_4$, N_2-CH_4.
Yu.P.Blahoi.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 577-85 (1959). In Ukrainian.

The densities were measured; the volumes of these solutions were found to be non-additive. A correlation is established between the value of the excess volume of mixing and the value of the energy of mixing and the compressibility of the solution. The experimental results are compared with the theoretical results, and a satisfactory agreement is obtained.

12874 COMPRESSIBILITY vs IONIC SIZE OF THE CATION IN THE AQUEOUS SOLUTIONS OF ELECTROLYTES.
M.Suryanarayana.

J. Acoust. Soc. Amer., Vol. 33, No. 9, 1245 (Sept., 1961).

The commpressibility of aqueous solutions of electrolytes with a common anion is found in the literature to decrease in some cases and increase in some others with the increase of the radius of the cation. It is suggested that the compressibility depends both on the hydration and the charge density of the ions, the effect on the compressibility of one being opposite to that of the other. The net trend of the compressibility depends on which factor is predominant.

12875 GENERAL THEORY OF POLYMER SOLUTIONS.

M.Fixman.
J. chem. Phys. (USA), Vol. 35, No. 3, 889-94 (Sept., 1961).

A general theory of the thermodynamic properties of polymer solutions is given. The theory is intended to be valid for every concentration range. The formalism begins with the assumption of some functional relation between the local free energy density, for an assigned polymer configuration, and the local concentration of segments belonging to various polymer chains. That is, the thermodynamic properties of the segments are presumed known, and the problem is taken to be the determination of changes in the thermodynamic properties which are induced by a joining of the segments into a polymer chain. The local segment concentration is assumed to be close enough to the bulk or average concentration that a Taylor series expansion of the local free energy can be made and cut off at the term containing the square of the fluctuation in local concentration. The resulting free energy of the whole solution can then be cast into a form which includes as one part the free energy of a random distribution of segments, and as a second part the free energy of an imperfect gas with a pairwise additive intermolecular potential, albeit a concentration-dependent potential. At low concentrations the results are identical to previous treatments based on imperfect gas theory. At high concentrations a previously introduced calculation of the radial distribution function is employed to show that the thermodynamic properties are accurately described as those of a random distribution of segments. The Flory—Huggins formula is an example of a free-energy function which can be assumed to hold locally at any concentration, but is then found to hold macroscopically only at high concentrations.

12876 ULTRASONIC VELOCITY IN SUPERCOOLED LIQUIDS.

S.Parthasarathy and V.N.Bindal.
Indian J. Phys., Vol. 34, No. 6, 272-7 (June, 1960).

The velocity of ultrasonic waves was studied over a range of temperatures extending into the supercooled region in five liquids: thymol, phenol, salol, benzophenone, and diphenylamine. It was found that the temperature coefficient of velocity, 1/v (dv/dt), does not remain the same on either side of the melting points in thymol and benzophenone. Salol, diphenylamine and benzophenone show a small abrupt change in velocity values as the melting point is crossed. These changes are attributed to possible structural changes encountered during transition from the liquid to the supercooled state, which must be associated with the corresponding change of adiabatic compressibility. Phenol does not show any discontinuity and the gradient is also the same over the whole range. As phenol is highly hygroscopic it is likely to be mixed with certain amount of water and presumably the presence of water masks the small variation in temperature gradient (if any).

12877 ULTRASONIC VELOCITY IN SOME AQUEOUS SOLUTIONS OF ELECTROLYTES.

P.R.K.L.Padmini and B.Ramachandra Rao.
Indian J. Phys., Vol. 34, No. 12, 565-76 (Dec., 1960).

The variation of ultrasonic velocity, adiabatic compressibility, apparent molal compressibility and molar sound velocity with concentration was studied in eleven electrolyte solutions. The results are interpreted in the light of Debye—Hückel's theory of electrolytes. The hydration numbers are estimated for all the electrolytes and compared with the data obtained by other methods. Nonlinear variations of molar sound velocity with molar concentration observed in some cases is explained in terms of molecular association and ionic solvation.

12878 PROPAGATION OF ULTRASONICS IN TRIETHYLAMINE—WATER MIXTURE.

S.Shimakawa.
J. Phys. Soc. Japan, Vol. 16, No. 1, 113-17 (Jan., 1961).

Velocity and attenuation of ultrasonic waves in a binary mixture of triethylamine—water were measured at different temperatures by using a pulse method at 1.5 and 2.5 Mc/s. Assuming a Gaussian distribution of relaxation times centering on the main relaxation frequency, calculation showed that this main frequency lies in a range of approximately 1 to 6 Mc/s and diminshes with increasing liquid temperature below the critical solution point. The prominent change of sound attenuation near the critical solution temperature depends mainly on the main relaxation frequency which varies with the liquid temperature.

12879 COMPRESSIBILITY OF ISOVISCOUS SUBSTANCES.

O.Z.Golik, Yu.I.Shimans'kyi and N.M.Kobiichuk.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 537-41 (1958). In Ukrain

The authors studied the velocity of sound and the compress bility in pure normal alcohols and their binary solutions. It is shown that, in a given system, substances having the same visc also have the same compressibility.

12880 MAGNETIC ROTARY POWER : ROTATIVITIES OF DISSOLVED ETHYL SULPHATES.

J.Grange.
Cahiers de Phys. (France), Vol. 15, 147 - 8 (March, 1961).
In French.

In an earlier paper (Abstr. 10788 of 1960) it was shown that covalent rotativities are additive quantities and this also holds f ionic rotativities. In this paper it is shown that the rotativities freshly prepared barium ethyl sulphate, potassium ethyl sulphat and ethyl sulphuric acid, all of which have the two types of bondi are equal to the sum of all the covalent and ionic rotativities. Measurements are made at 20°C and at a wavelength of 5780 A a at small concentrations. H.G.Jer

12881 LIGHT ABSORPTION IN PARAMAGNETIC IONS IN STATE OF SOLUTION. II. Ni^{++} ION.

A.Mookherji and N.S.Chhonkar.
Indian J. Phys., Vol. 34, No. 8, 363-80 (Aug., 1960).

The light absorption in aqueous solutions of nickel salts was studied in the range 10 000 to 3900 A by a Hilger Uvispek spectrophotometer and the results are discussed in the light of crystalline electric field theory. The cubic field coefficient has almost the same value in all the salts except the amino-salts. It observed that the term separation comes to be smaller for the i in a crystal than for the free ion. From this lowering the covalency factor f^2 was evaluated. f^2 tends to a value of 0.9 for a the salts except the amino-salts showing that f_π^2 is unity in them. In amino-salts f^2 arises from σ- and π-orbital overlap. Exceller agreement with the measured values of magnetic anisotropy was obtained by attributing the bands at 13 900 and 15 200 cm^{-1} as du to the splitting by a crystal field of tetragonal symmetry. The effect of long range field was observed to be very pronounced in single sulphate and selenate, double sulphates and selenates of K and Rb, while this was less pronounced in double sulphates and selenates of NH_4 and Tl.

12882 LIGHT ABSORPTION IN PARAMAGNETIC IONS IN STATE OF SOLUTION. I. CUPRIC IONS.

A.Mookherji and N.S.Chhonkar.
Indian J. Phys., Vol. 33, No. 2, 74-88 (Feb., 1959).

12883 INFRARED TRANSMITTANCE AND KERR EFFECT NITROBENZENE.

D.C.Cronemeyer and L.R.Spanberger.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1061-6 (Oct., 1961).

The infrared transmittance of nitrobenzene was measured fo wavelengths between 0.7 and 12 μ for seven samples ranging in thickness from 2 cm to about 10 μ. Other published information was used to extend these transmittance spectra to 25 μ. These over-all data are presented as an absorption-coefficient spectru from 0.7 to 25 μ. In addition, this absorption-coefficient spectru is analysed in terms of Kerr-coefficient information which may extrapolated from visible and near-infrared data. It is conclude that Kerr-cell modulation of a near-infrared light beam (to 2 μ) i feasible. Kerr-cell modulation in the 2–15 μ region appears to b unfeasible; however, there may be a good possibility of such operation in the 15–25μ range.

12884 ELECTROSTATIC MOLECULAR MODELS FOR THE KERR EFFECT IN NON-POLAR LIQUIDS.

R.Küste
Z. Naturforsch. (Germany), Vol. 16a, No.4, 366-74 (April, 1961).
In German.

The application of the model concepts of the work of Onsage (1936) to the Kerr effect is considered. Models are discussed which assume only anisotropy of molecular shape, only anisotrop of internal structure, or both types of anisotropy in a ratio determined by a single parameter. Two special models are considere in detail, which can describe the Kerr effect in terms of a single structure parameter. These are: (i) a model with exclusively anisotropy of molecular form, the effect being related to the mea effective value of the inner dielectric constant of the molecule (see Abstr. 282 of 1955); (ii) a model incorporating also structur anisotropy, but taking no account of molecular volume. Measurements are reported for pure liquids, and molecular properties c ated from such models and the measured Kerr constants are npared with values from other methods. Significant, but limited, :eement is obtained. In no case can variation of the ratio of xing of the two types of anisotropy lead to general agreement. sults for mixtures of non-polar liquids are also presented and ;cussed, with possible further applications of the models.

J.Sheridan

12885 U.V. SPECTRUM OF $KAuCl_4$.

A.Chakravorty.

turwissenschaften (Germany), Vol. 48, No. 9, 375 (1961).

Absorption bands at 315 mμ and 226 mμ in $KAuCl_4$ in HCl are ported. The former is ascribed to electron transfer from a lorine p-orbital to a gold $d_{x^2-y^2}$-orbital, and possible transitions : the 226 mμ band are discussed. J.E.Caffyn

12886 QUENCHING OF PHOTOLUMINESCENCE OF SOLUTIONS BY NON-ABSORBING FOREIGN)LECULES.

J.Glowacki.

:ta phys. Polon. (Poland), Vol. 19, No. 4, 513-23 (1960).

The theory of luminescence quenching, proposed by Jabłoński bstr. 854 of 1955), was checked experimentally for liquid and gid solutions of fluorescein, rhodamine B and "yellowish" eosin enched by KI and tartaric acid. With a simplified model of luminescence centre this theory agrees very well with the :perimental results on photoluminescence quenching. It was also und that, if the molecules are ions, the probability of transition a quencher from one group to another depends on the viscosity the solution and its temperature and on the charges of the minescent and quenching molecules and on the dielectric constant the solution.

12887 NEW EXAMPLES OF PRONOUNCED DEPENDENCE OF THE FLUORESCENCE YIELD ON THE POSITION IN HE LUMINESCENCE SPECTRUM.

.N.Viktorova, A.S.Kochemirovskii, N.D.Krasnitskaya and I.Reznikova.

ptika i Spektrosk. (USSR), Vol. 9, No. 4, 544-6 (Oct., 1960).
ı Russian.

Zelinskii et al. (Abstr. 4220 of 1957) showed that in five hthalimide derivatives there was a regular relationship between ie absolute quantum yield of fluorescence at 20° C in various sol- ents and the frequency of the fluorescence spectrum maximum. he present paper reports a similar dependence for dimethylnaph- arhodine, 2-aminoacridine, and cyclohexylaminomaleinimide at)° C. [English translation in: Optics and Spectrosc. (USA), Vol. 9, o. 4, 288-9 (Oct., 1960)]. A.Tybulewicz

12888 THE DURATION OF ULTRAVIOLET FLUORESCENCE OF CERTAIN AROMATIC COMPOUNDS.

.V.Ivanova, P.I.Kudryashov and B.Ya.Sveshnikov.

okl. Akad. Nauk SSSR, Vol. 138, No. 3, 572-4 (May 21, 1961).
ı Russian.

The decay times of the fluorescence of a number of organic ıbstances in various solvents were determined for excitation ith 2700 A illumination. These times are tabulated, and the effects different solvents on a given substance discussed. [English ranslation in: Soviet Physics—Doklady (USA)]. K.N.R.Taylor

12889 PHASE RELATION BETWEEN SONOLUMINESCENCE AND CAVITATING BUBBLES.

K.Negishi.

custica (Internat.), Vol. 10, No. 2, 124 (1960).

Sonoluminescence and scattered light from bubbles in water ere observed by means of a photomultiplier output displayed on an scillograph triggered by the input voltage to the exciting transducer. he bubble size and sonoluminescence intensity were photographed ıccessively and suggest that the luminescence occurs at the ıstant of cavity collapse. When a microphone was placed in the avitation region it was seen that minimum size of the cavities orresponded to a sharp pressure maximum, presumably produced y superposed shock waves resulting from cavity collapse. I.Cooke

12890 EFFECT OF A MAGNETIC FIELD ON THE DIELECTRIC CONSTANT OF PURE LIQUIDS.

..Piekara and A.Chelkowski.

rch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 11-13 (1960).
ı French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A brief ummary is given of the theory of the effect of a magnetic field n the dielectric constant of liquids and the calculation of $\epsilon^{m} = Q^{em} S^{em}_{M} H^2$, where Q^{em} contains the macroscopic quantities, H is the intensity of the magnetic field, and S^{em}_{M} is the molar constant of saturation in a magnetic field, derivable from the Cotton—Mouton and Kerr constants. The values derived for $\Delta\epsilon^{m}$ for nitrobenzene are 3.6×10^{-14} H^2 if the Lorentz internal field is used and 2.6×10^{-14} H^2 using the Onsager field. Measurements made by a differential method to obviate eddy current heating of the condenser plates gave for nitrobenzene, the value $(2.6 \pm 0.3) \times 10^{-14}$ H^2 in agreement with the value derived from the Onsager field.

R.G.C.Arridge

12891 HYDROGEN BONDING AND DIELECTRIC SATURATION.

A.Piekara.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 14-17 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Dielectric saturation, the diminution of the dielectric constant, measured in an alternating electric field, by the addition of a polarizing field is discussed. The diminution is proportional to the square of the field strength, the factor of proportionality containing three terms: from the Cotton—Mouton effect, the Kerr effect, and a polarization term. A new type of dielectric saturation is reported, which is negative in pure polar liquids, becoming positive on dilution with a non-polar liquid. The effect is found in certain alcohols and is held to be intermolecular in origin. An explanation in terms of the hydrogen bonds between the alcohol molecules is put forward. R.G.C.Arridge

12892 DIELECTRIC ANISOTROPY AND DIELECTRIC LOSS OF SOME LIQUID CRYSTALS.

W.Maier and G.Meier.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 38-9 (Sept., 1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The principal polarizabilities of various azoxybenzenes and azobenzenes were measured at frequencies from 0.1 to 4 Mc/s and the values found were in good agreement with those derived from bond polarizabilities. The results support the theory of Maier and Saupe (Abstr. 5007 of 1960). R.G.C.Arridge

12893 HERTZIAN SPECTRA OF SOLUTIONS OF n-HEXANOL IN OCTANE.

M.Moraimez and A.Lebrun.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 40-7 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The real and imaginary (absorption) components of the dielectric constant were measured. There is a low-frequency absorption maximum varying with temperature (+ 50° to -50° C) and with concentration through the range 2-400 Mc/s. This is attributed to orientation of dipoles momentarily bound by hydrogen bonding, the lifetime of the bond determining the critical frequency. G.F.Lothian

12894 ON THE RADIOFREQUENCY [ABSORPTION] SPECTRA OF SOME SATURATED MONOCARBOXYLIC ACIDS.

E.Constant and A.Lebrun.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 54-61 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Real and imaginary components of the dielectric constant were determined for acetic and propionic acids at temperatures from -20° to 90°C. For acetic acid, two absorption frequencies near 2 and 10 Gc/s are attributed to open chain polymers. For propionic acid a frequency near 5 Gc/s is attributed to open chain polymers and a high frequency (40-170 Gc/s) to the end of a polymer chain and to free molecules. G.F.Lothian

12895 DIELECTRIC RELAXATION PHENOMENA AND INTRAMOLECULAR DIPOLE MOTION OF ANILINES IN DILUTE SOLUTION.

H.Kramer.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 65-7 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The microwave absorption of various chloro- and methyl-substituted anilines was measured down to λ = 7 mm. The absorption curves were fitted best by using two Debye terms according to Budo's theory for rotating groups. The influence of the substituents on the mobility of the NH_2 group is noticeable only in the ortho-position, and only to a small extent. R.G.C.Arridge

12896 DIELECTRIC RELAXATION SPECTRA OF ALKYL CHLORIDES IN DILUTED SOLUTIONS.

G.Klages and R.Langpape.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 68-9 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961).

Discusses the contribution of the internal mobility of the aliphatic chain to dipole orientation in low-molecular compounds and dilute solutions. The loss factors ϵ" at centimetre and millimetre wavelengths were measured on a series of chlorides with different chain lengths and different positions of the dipole within the chain. The position and shape of the curve of absorption as a function of frequency are discussed with reference to various models.
R.G.C.Arridge

12897 THE DIELECTRIC PROPERTIES OF SOME α-ω DIBROMO ALKANES. A.H.Price.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 71-6 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The dielectric properties of some α-ω dibromo alkanes were measured in the frequency range 1-8.5 Gc/s together with viscosity and refractive index determinations. The loss factor varies with frequency and this is analysed by the Fuoss—Kirkwood equation. The relation between viscosity and relaxation time is discussed in terms of the Debye theory and a change in molecular shape with increasing chain length is proposed to account for the anomalies.
R.G.C.Arridge

12898 MOLECULAR ROTATIONAL RELAXATION IN LIQUIDS AND SOLIDS. C.Clemett and M.Davies.
Arch Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 77-81 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The dielectric properties of some liquids and solids were measured in the region 250-920 Mc/s. For the liquid measurements a temperature range up to 100°C was used; for the solids the range was limited by the difference between the melting point and transition temperature at which rotational freezing occurs. 2chloro-2nitropropane, methyl chloroform, succinonitrile and t-nitrobutane were used. The relaxation times were calculated from the Eyring formula and compared with those calculated by a method due to Bauer.
T.E.Peacock

12899 CONDUCTIVITY INDUCED BY INJECTED ELECTRONS IN LIQUID DIELECTRICS.
P.Chong, T.Sugimoto and Y.Inuishi.
J. Phys. Soc. Japan, Vol. 15, No. 6, 1137-8 (June, 1960).

Spark-generated light pulses of 4 μsec duration were used to inject photoelectrons from a magnesium cathode into different liquids. At 20°C the drift velocity in d.c. fields of 50 to 150 kV/cm was 0.85×10^{-3} cm^{2}V^{-1}sec^{-1}in n-hexane (viscosity 3×10^{-3} poise) and 0.42×10^{-3} cm^{2}V^{-1}sec^{-1} in benzene, (viscosity 6×10^{-3} poise). Evidently this represents the mobility of negative ions formed by electron attachment.
J.H.Mason

12900 LONGITUDINAL AND TRANSVERSE NUCLEAR RELAXATION IN PURE LIQUIDS AND COLLOIDAL SOLUTIONS. G.Bonera, L.Chiodi, G.Lanzi and A.Rigamonti.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 445-51 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). In several pure liquids a single value of T_1 was found for protons even though the molecules contained non-equivalent protons. T_1 was greater than T_2 in some cases, due to a surface effect. The concentration dependence of T_1 and T_2 in colloidal solutions of fish-glue and silica gel was related to the lifetimes of water molecules in adsorbed phases.
E.F.W.Seymour

12901 PROTON RELAXATION AND HYDRATION IN AQUEOUS SOLUTIONS OF Mn^{++} IONS. H.Pfeifer.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 464-6 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The temperature variation of T_1 and T_2 measured at 4 Mc/s and 16 Mc/s for protons in water containing 3×10^{18} Mn^{++} ions/cm^3 suggests that the water molecules surrounding the ions become more radially orientated with increasing temperature.
E.F.W.Seymour

12902 PROTON MAGNETIC RESONANCE STUDY OF HYDROGEN BONDED SYSTEMS.
S.S.Dharmatti, G.Govil, C.R.Kanekar and Y.P.Virmani.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 479-94 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The concentration dependence of proton chemical shifts in solutions of formic, acetic, and difluoroacetic acids, in water—dioxane and water—acetone mixtures, and in solutions of coumarin in several solvents, was measured and interpreted in terms of dimer formation (formic acid, difluoroacetic acid) and hydration (acetic acid, dioxane). Dimerization of coumarin was not indicated.
E.F.W.S

12903 1. HIGH RESOLUTION N.M.R. STUDIES OF INTRA- AND INTER-MOLECULAR INTERACTIO
2. PYRIDINE DERIVATIVES; THE EFFECT OF PARAMAGN SALTS ON ETHANOL AND PYRIDINE.
M.Freymann, R.Freymann and C.Geissner-Prettre.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 506-13 (19
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A summary of work at the Laboratoire de Spectroscopie Hertz Paris, in 1959-60, with fuller details of chemical shift measu ments on 19 pyridine derivatives, and of the broadening and s of the spectra of ethanol and pyridine due to small concentrat of dissolved paramagnetic salts.
E.F.W.Se

12904 NUCLEAR RESONANCE EXPERIMENTS AT LOW FIELD WITH A FLOWING LIQUID. J.Hennequin.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 634-9 (1960
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Apparatus is described in which intense signals in weak fields are obtained by pumping the liquid through a high field in whic the nuclei are polarized before entering a coil in the weak fiel The earth's field can be conveniently and precisely measured. Results are reported for proton resonances in a concentrated solution of sodium hypophosphite at frequencies below 4 kc/s. spin coupling constant between phosphorus and hydrogen is ob with improved accuracy.
J.Sh

12905 FORM AND STRUCTURE OF MAGNETIC RESONA LINES IN LIQUIDS AT VERY LOW FREQUENCIE
G.J.Béné.
Helv. phys. Acta (Switzerland), Vol. 33, No. 8, 941-4 (1960).
In French.

Magnetic resonance at low frequencies has been studied a radiofrequency spectroscopy laboratory of the University of G since the autumn of 1954. Electron resonance has been obser between 60 and 150 kc/s and nuclear resonance between 2 and 150 kc/s. The principal problems of working at these frequen are discussed. The results obtained, experiments in progress proposed are described.
J.M

12906 NUCLEAR SPIN ECHOES AND MOLECULAR SEL DIFFUSION IN LIQUIDS. S.K.Ghosh and S.K.Sinha
Indian J. Phys., Vol. 34, No. 8, 339-57 (Aug., 1960).

The treatment on the basis of a new stochastic model; the physical and mathematical inconsistencies of similar treatme reported earlier are also discussed. A spin-echo method for measuring the coefficient of molecular self-diffusion D directl using the "image echo" was developed, which completely elimi ed the relaxation damping of the echo signal. It was shown tha diffusion damping coefficient k thus determined could be utiliz for an independent measurement of transverse relaxation time even in presence of appreciable diffusion. These methods wer used in the case of water, and the values of D and T_2 obtained agree well with other measurements. Further, a direct experi mental check was furnished to compare the validity of differen retical approaches to this problem.

12907 NUCLEAR MAGNETIC RESONANCE IN FLOWING FLUIDS. L.R.Hirschel and L.F.Libelo.
J. appl. Phys. (USA), Vol. 32, No. 7, 1404-5 (July, 1961).

From the BPP equations an expression is derived which g the signal strength of steady state resonances as a function of time spent by the sample in the static magnetic field, the time in the r.f. field, the velocity of fluid flow, and the degree of saturation.
P.M.P

THE DYNAMIC POLARIZATION OF NUCLEI IN SOLUTIO FREE RADICALS. See Abstr. 12311

MECHANICS OF GASES

2908 GAS FLOW THROUGH A LAVAL TUBE.
O.S.Ryzhov.
lad. Mat. i Mekh. (USSR), Vol. 22, No. 3, 396-8 (1958).
ussian.

It is assumed that the cross-section of the tube has tetragonal igher symmetry. The equations of motion for irrotational flow solved for an ideal gas passing through the tube at a speed roaching the velocity of sound. Only those types of movement considered in which there is no discontinuity of the type of a k front. The present note is mainly concerned with finding the pe of the surface on which the velocity of sound is attained. ressions are derived by which this surface is specified.
R.Eisenschitz

12909 TRANSONIC FLOW PAST A WAVY WALL.
I.Hosokawa.
Phys. Soc. Japan, Vol. 15, No. 11, 2080-6 (Nov., 1960).

Transonic flows past a sinusoidal wall,including shock waves, e studied by use of a new method, and the velocity and pressure tributions on the wall were determined. The result gives a sonable model for understanding the transition of the flow tern from subsonic to supersonic.

12910 THEORETICAL PREDICTION OF THE PRESSURE DISTRIBUTION ON A NON-LIFTING, THIN SYMMETRI-L AEROFOIL AT VARIOUS TRANSONIC SPEEDS. I.Hosokawa.
Phys. Soc. Japan, Vol. 16, No. 3, 546-58 (March, 1961).

Theoretical pressure distributions on a non-lifting, circular- aerofoil at various transonic speeds are obtained by applica- n of a new method recently published by the author (Abstr. 6884 1961). The method consists essentially of a refinement of the earized transonic flow theory in which the nonlinear character- ics of the fundamental equation are taken into account. The sults reveal most of the principal phenomena observed in experi- ntal studies throughout the whole Mach number range.

hock Waves

12911 STRONG BLAST WAVES IN SPHERICAL, CYLINDRICAL AND PLANE SHOCKS. D.L.Jones.
ys. of Fluids (USA), Vol. 4, No. 9, 1183-4 (Sept., 1961).

The writer machine-computes the dimensionless energy rameter first introduced by Taylor (Abstr. 4777 of 1950) which aracterizes the spatial—temporal behaviour of strong blast waves om a point source for spherical, cylindrical and plane waves. He ds considerable disagreement between his exact computations d the approximate calculations of most other workers.
M.McChesney

12912 APPARENT INTERMEDIATE SUPERVELOCITY OF DETONATION. C.H.Johansson.
ture (GB), Vol. 190, 709-10 (May 20, 1961).

12913 A PROBLEM IN SHOCK WAVES.
R.S.Mishra.
ovo Cimento (Italy), Vol. 20, No. 4, 605-9 (May 16, 1961).

Landau and Lifshitz (1959) mentioned the following result: If o (or more) successive shock waves take a gas from state 1 to ate 2 and from there to state 3, the transition from state 1 to ate 3 cannot, in general, be effected by the passages of any one ock wave. The object of this note is to obtain conditions for the ansition from state 1 to state 3 to be effected by the passage of y one shock wave.

12914 MAGNETICALLY DRIVEN CYLINDRICAL SHOCK WAVES. H.W.Liepmann and G.Vlases.
ys. of Fluids (USA), Vol. 4, No. 7, 927-8 (July, 1961).

Gives a brief summary of some experiments on cylindrical ock waves, produced by magneto-fluid dynamical methods. The sults for unsteady axisymmetric flow may be related (by means of yes' hypersonic similitude) uniquely to an equivalent problem steady hypersonic flow which could otherwise be difficult to vestigate experimentally.
N.Curle

GROWTH OF HYDROMAGNETIC SHOCK WAVES.
See Abstr. 13169

12915 DETONATION-GENERATED PLASMAS.
A.Bauer, M.A.Cook and R.T.Keyes.
Proc. Roy. Soc. A (GB), Vol. 259, 508-17 (Jan. 24, 1961).

Photographic sequences at the rate of a million exposures a second of the brilliantly luminous, highly ionized gas clouds or detonation-generated plasmas emitted from free surfaces of detonating explosives, showing interesting compressional, extrusion and expansion effects are presented and discussed. Means of separating and differentiating the shock waves and plasmas associated with the detonation of condensed explosives are illustrated. Examples of plasma explosions are presented illustrating the particular metastable character of these plasmas. Measurements of the velocity—conductivity—density relations in the plasmas are presented and their resemblance to metals discussed.

12916 SELF-IGNITION OF HYDROCARBON-AIR MIXTURES IN SHOCK WAVES. K.Terao.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2086-92 (Nov., 1960).
In German.

The ignition mechanism of hydrocarbon—air mixtures is discussed. The ignition probabilities of various hydrocarbon—air mixtures are computed from the fluctations of their ignition lags in shock waves. From these ignition probabilities, the activation energies of the primary and secondary reactions are calculated. Next, the activation energies for the C—H and C—C bonds in the reaction with oxygen are estimated, as well as the amount of heat liberated for secondary reactions. The mean ignition lags of other n-paraffin—air mixtures are, in accord with the experimental conditions, estimated from the above determined values.

12917 VISIBLE PRECURSOR RADIATION IN AN ELECTRO-MAGNETIC SHOCK TUBE.
E.A.McLean, A.C.Kolb and H.R.Griem.
Phys. of Fluids (USA), Vol. 4, No. 8, 1055-6 (Aug., 1961).

Visible precursor signals of He λ 5876 are detected using a photomultiplier and a special circuit which eliminates electrical noise in the cable. With shocks around 40 000°K the intensity is 1% to 2% of the radiation of the shock itself. Photoionization by a vacuum ultraviolet precursor is believed to be followed by three-body recombination to excited states causing the visible precursor radiation. Comparison of line width shows that it is not due to scattered light. Most of the precursor is due to u.v. radiation from the initiating arc discharge, but about 10% comes from the shock heated gas.
A.G.Gaydon

STAGNATION TEMPERATURE MEASUREMENTS IN A HYPERSONIC WIND-TUNNEL USING THE SODIUM LINE REVERSAL METHOD. See Abstr. 13015

GASEOUS STATE

12918 VARIOUS APPROXIMATIONS FOR THE ISOTOPIC THERMAL DIFFUSION FACTOR. I. APPLICATION TO HELIUM ISOTOPES. S.C.Saxena and P.A.Pardeshi.
Indian J. Phys., Vol. 35, No. 2, 55-61 (Feb., 1961).

Various formulae for the isotopic thermal diffusion factor are reviewed and a new formula is derived. Numerical calculations are performed for the particular case of He^3—He^4 in a region where quantum effects are negligible. These calculations establish the relative adequency of a comparatively simple formula which is proposed.

12919 RAPID DETERMINATION OF GASEOUS DIFFUSION COEFFICIENTS BY MEANS OF GAS CHROMATOGRAPHY APPARATUS. J.C.Giddings and S.L.Seager.
J. chem. Phys. (USA), Vol. 33, No. 5, 1579-80 (Nov., 1960).

In the apparatus the packed column is replaced by an empty tube of circular cross-section. The height equivalent to a theoretical plate for a circular tube being expressible in terms of the average gas velocity, the tube radius, and the diffusion coefficient, enables the latter to be determined in less than a minute and with only a minute amount (10^{-6} mole) in the carrier gas. The diffusion of hydrogen peaks into a nitrogen carrier is investigated. The average diffusion coefficient from 21 determinations was 0.7975 cm^2/sec at 293°K. The precision is about 2%.
W.Good

12920 MEASUREMENT OF THE $O—O_2$ DIFFUSION COEFFICIENT.

R.E.Walker.

J. chem. Phys. (USA), Vol. 34, No. 6, 2196-7 (June, 1961).

For sufficiently low flow velocities in a tubular flow reactor, one-dimensional flow can be retained in which axial diffusion is not negligible. Measurement of the axial decay of relative oxygen atom concentration for different flow velocities suffices to determine the diffusion coefficient for the labile atom. NO was introduced in trace amounts to the $O—O_2$ mixture and the afterglow intensity (arising from the reaction of O with NO) determined by a photomultiplier tube to give a measure of the O atom concentration. The average value of D was found to be 0.302 ± 0.012 cm^2/sec at 1 atm.

W.Good

12921 DEFINITION OF THE PERFECT GAS.

P.T.Landsberg.

Amer. J. Phys., Vol. 29, No. 10, 695-8 (Oct., 1961).

Usual definitions are analysed, and changes are proposed. The considerations advanced here lead to a view which, in its most extreme form, might run as follows: The ideal gas concept as used at present is unduly influenced by classical ideas, and out-of-date; but it can readily be modernized. The proposal is to define the ideal gas by the equation of state $pv = gU$, where g is a constant. The ideal classical gas is defined by the additional relation $pv = NkT$. These two equations lead to a system whose heat capacities C_V, C_p are independent of temperature, as normally required in elementary discussions. In other words, it is proposed that the ideal gas shall remain a generalization of the system for which $pv = NkT$ and C_V and C_p are temperature independent, but it shall be defined by $pv = gU$ rather than by $pv = NkT$.

12922 DEVELOPMENT OF THE KINETIC THEORY OF GASES. V. THE EQUATION OF STATE.

S.G.Brush.

Amer. J. Phys., Vol. 29, No. 9, 593-605 (Sept., 1961).

For Pt IV see Annals of Science (USA), Vol. 14, 243 (1958). Some early attempts to explain deviations from the ideal gas laws are discussed. After a general survey of 19th-century work on the equation of state, the work of Ritter (1846), Clausius (1870), and van der Waals (1873) is discussed in detail. Ritter used Poisson's formula to include the virial of interatomic forces in the caloric theory of gaseous pressure; Clausius introduced similar methods in the kinetic theory. Combined with the Maxwell—Boltzmann distribution law, the virial theorem provided a systematic procedure for calculating the pressure from any assumed force law. Van der Waals used more intuitive methods for taking account of the effect of finite molecular size and attractive forces. The success of his equation led to a large amount of work on the equation of state, but rigorous deduction from definite molecular models did not begin until around 1900.

12923 ON THE CLASSICAL BOLTZMANN EQUATION FOR GASES.

F.C.Andrews.

J. chem. Phys. (USA), Vol. 35, No. 3, 922-4 (Sept., 1961).

The Boltzmann equation is simply formulated for dilute classical gases from the reduced Liouville equation by using the three assumptions: no three-body effects, collision time much less than the experimental time, and negligible change in local properties of the system over distances of order of the range of the intermolecular forces. The nature of these assumptions sheds some light on recent attempts to generalize the Boltzmann equation. It is found that it is easy formally to relax the first assumption to permit more than two-body effects. The resulting equation is an intuitive extension of the Boltzmann equation.

12924 THEORY OF TRANSPORT PHENOMENA IN GASES.

E.G.D.Cohen.

Ned. Tijdschr. Natuurkde (Netherlands), Vol. 26, No. 11, 325-44 (Nov., 1960). In Dutch.

This is the first part of a survey of the transport theory of gases and deals with dilute gases. Different theories are classified in three categories: mean free path theories (Clausius, Maxwell, Jeans), Boltzmann equation theories (Chapman, Enskog, Hilbert, Boltzmann), and Liouville equation theories (Bogolyubov). The last class of theories is not discussed in this part as it is particularly suited for dense gases. The Chapman-Enskog theory is discussed in detail.

Mathematical Reviews (D.ter Haar)

12925 MOMENTUM-CORRELATION FUNCTION IN A RAYLEIGH GAS.

R.M.Mazo.

J. chem. Phys. (USA), Vol. 35, No. 3, 831-5 (Sept., 1961).

The time-correlation function in an equilibrium ensemble of the momentum of a heavy particle imbedded in a gas of non-inte light particles is calculated. The technique used is a density sion of the correlation function. No statistical hypothesis be that of canonical ensemble at the initial time is used.

DYNAMICS OF IONIZED GASES. See Abstr. 13066

QUANTUM STATISTICS OF SURFACE EFFECT.
See Abstr. 12820

12926 APPROXIMATE INFRARED EMISSIVITY CALCUA TIONS FOR HCl AT ELEVATED TEMPERATURE

S.S.Penner and L.D.Gray.

J. Opt. Soc. Amer., Vol. 51, No. 4, 460-2 (April, 1961).

Numerical values of the spectral absorption coefficients in good agreement with those of Plass [Stull and Plass, Spect emissivity of hydrogen chloride from 1000-3400 cm^{-1}, Publ. U-461, Aeronutronic, Newport Beach, California, (May 15, 19 using machine computations may be obtained using a relative simple analytical treatment.

G.I.W.L

12927 A METHOD OF DETERMINING THE RADIATION PROBABILITY OF GASES AND VAPOURS.

Ya.I.Gerlovin.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 664-5 (Nov., 1960) In Russian.

Describes a method of determining the probability of spo eous radiation at wavelengths of rotation—vibration absorptio bands of gases and vapours. The method is based on a compa of the intensities of emission by a gas and a black body at the temperature, which is higher than the temperature of the rad receiver. The method was applied to carbon dioxide gas in th region of the 4.3 mμ absorption band at room temperature. A telluride photoresistor, cooled with liquid air, was used as a receiver. The probability of radiation in the 4.3 mμ region w found to be 350 sec^{-1}. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 349-50 (Nov., 1960)].

A.Tybu

12928 THE TEMPERATURE DEPENDENCE OF THE VIBRATIONAL ABSORPTION BAND INTENSITIES GASES.

M.P.Lisitsa and V.L.Strizhevskii.

Optika i Spektrosk. (USSR), Vol. 10, No. 1, 48-54 (Jan., 1961). In Russian.

Considers theoretical aspects of the temperature of the i grated intensities of vibrational absorption bands of gases. D formulae which give the temperature dependence of integrated absorption which differ somewhat from the usual formulae. C parison of the available experimental data with the new formu shows fairly good agreement with experiment, but further w necessary for reliable conclusions. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 23-7 (Jan., 1961)]

A.Tybu

12929 THE FLUORESCENCE OF ACETALDEHYDE VA

E.Murad.

J. phys. Chem. (USA), Vol. 64, No. 7, 942-5 (July, 1960).

The diffuse fluorescence spectrum of the vapour was fou to extend from 3515 A to 4700 A with a maximum near to 4000 Additional peaks were observed at 3565 A, 3640 A and 3783 A. spectral resolution was insufficient to reveal further detail. Banded emission components observed with a static vapour ar attributed to biacetyl; this emission swamps the acetaldehyde emission in the impure vapour. The relative efficiency, Q, of fluorescence stimulated by 3340 A radiation was found to be i pendent of temperature between 26°C and 52°C and was unaffe by the presence of oxygen. It is concluded that the excited sta is a triplet and the measured dependence of Q on the vapour p is due to collisional deactivation and decomposition. With 313 3020 A and 2980 A stimulating radiation, Q was partly quenche the presence of oxygen and the general behaviour was similar that shown by biacetyl stimulated by 3660 A radiation. A mec which invokes the presence of a triplet state is suggested to a for the data. Results obtained on the effect of biacetyl on the acetaldehyde emission give important evidence for the propos mechanism.

P.J

12930 DISPERSION OF MICROWAVES IN OXYGEN.

P.Swarup and S.K.Garg.

Indian J. Phys., Vol. 35, No. 1, 28-33 (Jan., 1961).

The dispersion of microwaves in gaseous oxygen is calcu

basis of the Van Vleck—Weisskopf expressions for collision-
ened microwave spectral lines. Curves are plotted at
ures of $\frac{1}{4}$, 1, 2, 10, 25 and 50 atm in a wide frequency band
or resonant and nonresonant cases. The calculated value of
magnetic susceptibility agrees with the known experimental
.

EFFECT OF RELAXATION OF CHEMICAL ENERGY ON THE
RMAL CONDUCTIVITY OF THE SYSTEM $N_2O_4 \rightleftharpoons 2NO_2$.
bstr. 12673

VACUUM PHYSICS

2931 A TITANIUM PUMP.
I.A.Hrishayev, B.A.Terekhov, L.K.Möyakushko
I.L.Fursov.
yin fiz. Zh. (USSR), Vol. 4, No. 6, 750-4 (1959). In Ukrainian.
The pump works on the principle of absorption of gas by the
ber walls on which titanium dust continuously settles. A
le ionization system secures the evacuation of inert gases. The
of evacuation of air at a pressure of 10^{-6} mm Hg is about
tres sec; expenditure of titanium, 0.05 mg/min. The pump
s operating at a pressure of $\sim 10^{-2}$ mm Hg. A description is
of a pump design, which permits increasing the stock and
nditure of titanium. The rate of evacuation in such a pump is
100 litres/sec with an air pressure of 2×10^{-7} mm Hg and the
ium expenditure is 1 mg/min.

2932 MAGNETIC IONIZATION MANOMETER.
V.M.Havrÿlyuk.
ayin. fiz. Zh. (USSR), Vol. 4, No. 5, 679-81 (1959). In Ukrainian.
Operates in the range 10^{-4}-2×10^{-9} mm Hg.

2933 HIGH VACUUM APPARATUS FOR STUDYING THE
LUMINESCENCE OF SOLIDS. H.W.Gandy.
. sci. Instrum. (USA), Vol. 32, No. 9, 1019-21 (Sept., 1961).
A high vacuum device was designed and constructed for the
stigation of luminescence from powdered or single luminophor
ples when excited by several means. In the present design,
y samples can be investigated at temperatures both above and
w that of ambient without the necessity of breaking the vacuum
e system. The samples may be excited either by an electron
n, a beam of electromagnetic radiation, or coexcited by both.

METHOD FOR EVAPORATION IN VACUUM OF SUBLIMABLE
TERIALS. See Abstr. 12665

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

12934 DYNAMICS OF THE VIBRATION OF BAR EXCITED
BY TRANSVERSE IMPACT OF A LOAD (EXPERI-
NTAL). K.Ray.
ian J. theor. Phys., Vol. 8, No. 1, 1-17 (March, 1960).
Deals with the experimental arrangement for the study of
duration of impact, when a particular hammer strikes the free
s of bars of different lengths or when different hammers strike a
ticular bar at the free end; (2) maximum amplitude of vibration
ing impact when different hammers strike the free end of a
. and (3) relative loss of energy of the hammer due to impact
h bars of different mass-ratios. Theoretical expressions for
above quantities have previously been developed by Ghosh and
. The special case of a hard hammer of comparatively heavy
ss-ratio is discussed. The agreement between theory and
eriment is found to be excellent.

12935 NOTE ON THE TORSIONAL VIBRATION OF A THIN
BEAM OF VARYING CROSS-SECTION. A.K.Mitra.
ian. J. theor. Phys., Vol. 8, No. 1, 23-6 (March, 1960).
In order that the frequency equation can take a simple form, it
ssumed that the moment of inertia and the torsional rigidity be
portional to exp(4ks) where s is the span-wise coordinate and k is a
number. This assumption holds for an exponentially tapering
.

STRUCTURAL FATIGUE UNDER COMBINED SINUSOIDAL
D RANDOM VIBRATION. See Abstr. 12585

12936 DYNAMICS OF THE LONGITUDINAL PROPAGATION OF ELASTIC DISTURBANCE THROUGH A MEDIUM EXHIBITING GRADIENT OF ELASTICITY. S.K.Ghosh.
Indian J. Phys., Vol. 35, No. 1, 22-7 (Jan., 1961).

Extensional vibration in an isotropic medium for linear variation of elastic parameters is considered, using operational methods. Two distinct cases are evaluated from the general solution: (1) for a source having impulsive force at one end, the other end remaining free, and (2) impulsive force at one end, the other end being fixed. Solution obtained in the form of modified Bessel functions are further simplified for small variations of the parameter, using the method of steepest descents as adopted by Debye.

ACOUSTICS

12937 GENERATION OF SOUND IN CAVITIES BY FLOW RATE CHANGES. P.A.Franken.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1193-5 (Sept., 1961).

Sound generated by mass or heat flow changes in a cylindrical cavity is considered. The special case of a high-pressure-ratio orifice is studied. Experimental results show good agreement with values predicted from a scaling equation.

12938 ACOUSTIC INTENSITY ANAMOLIES: COMMENTS ON A PAPER BY PEDERSEN. K.R.Stewart.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1248 (Sept., 1961).

See Abstr. 6928 of 1961. By use of a ray acoustical model of the ocean with linear sound speed gradients, the intensity is calculated when a ray is horizontal at a layer interface.

12939 REMARKS ON MR. STEWART'S COMMENTS ON MY PAPER ENTITLED "ACOUSTIC INTENSITY ANOMALIES, ETC". M.A.Pedersen.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1248 (Sept., 1961).

12940 DIFFERENCE OF LOUDNESS IN PLANE-WAVE AND DIFFUSE SOUND FIELD. W.Kuhl and W.Westphal.
Acustica (Internat.), Vol. 9, No. 5, 407-8 (1959). In German.

Discusses papers by Robinson and Dodson (Abstr. 4280 of 1956) and Stevens (Abstr. 195 of 1957) on loudness measurements for pure tones and complex noise. An experimental curve is shown which indicates the level difference in diffuse sound field and free sound field (plane wave) for third band pass sounds of equal loudness, in the frequency range 10^2 and 10^4 c/s, in three cases: (a) Room 1, $V = 270$ m^3, $T = 0.8$ sec, 12 loudspeakers in a ring; (b) as in (a) with two additional spherical loudspeakers, and (c) Room 2, $V = 125$ m^3, $T = 1.8$ sec, 12 loudspeakers in a ring, 12 large diffusers. The experimental curve shows the mean square departure has a maximum value of ±1.5 dB. Between 5000 and 12 000 c/s for equal loudness the sound pressure in the diffuse sound field is about 7 dB smaller than in the plane wave. A.B.Wood

12941 PROPAGATION OF SOUND WAVES IN VISCO-ELASTIC COMPRESSIBLE FLUIDS. S.K.Sharma.
J. Sci. engng Res. (India), Vol. 2, 253-8 (1958).

The propagation of small amplitude disturbances is investigated for a viscoelastic fluid whose properties are characterized by a bulk viscosity coefficient and a constitutive shear equation of the form $\Sigma + \tau\dot{\Sigma} = 2\mu\dot{\epsilon}$ where, in the reviewer's non tensor notation, Σ denotes shear stress, ϵ is shear strain, τ is a relaxation time and μ is the shear viscosity coefficient. In section 2 the linearized equations are solved for periodic disturbances for the cases of (a) spherical waves, (b) plane waves in which the velocity vector is parallel to the direction of propagation; for this second case the dispersion relation, connecting phase velocity with circular frequency, is obtained in a first non-trivial approximation. Section 3 is concerned with the modifications entailed in the plane wave case if allowance is made for thermo-mechanical effects. Mathematical Reviews (S.C.Hunter)

12942 SOUND PROPAGATION OVER OCEAN WATERS IN FOG. F.M.Wiener.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1200-5 (Sept., 1961).

Audible fog signals are extensively used as aids to marine navigation during periods of low visibility. Performance, however, has frequently been inadequate. To obtain a better understanding of the physics of sound propagation over water in fog, a series of field experiments was carried out off the coast of Maine. Signals in the frequency range between about 200 and 2000 c/s were employed to measure sound attenuation for distances up to a few miles. Simultaneous micrometeorological measurements were performed to describe the relevant properties of the lowest layers of the atmosphere through which the sound was propagated. The measurement techniques used are briefly described and typical samples of the results obtained are presented. Downwind, the average excess attenuation over and above inverse square law can be accounted for principally by molecular absorption. Upwind, large values of excess attenuation were found due to shadow zone formation. This constitutes a severe limitation of the useful range of audible fog signals. Fog itself contributes little to the average excess attenuation.

12943 STEPPED WAVEGUIDE TRANSFORMERS AND FILTERS. L.Young.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1247 (Sept., 1961).

A review of recent developments in the synthesis of stepped quarter-wave transformers and half-wave filters is given. A recent paper by Holte and Lambert (Abstr. 5325 of 1961) is discussed.

SOUND-SPEED MEASUREMENTS UTILIZING THE BATHYSCAPH TRIESTE. See Abstr. 12685

12944 INTERFERENCE VERSUS FREQUENCY IN MEASUREMENTS IN A SHALLOW LAKE. R.J.Bobber.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1211-15 (Sept., 1961).

When an omnidirectional projector and hydrophone are closely spaced and in shallow water, and sound is transmitted from one to the other, a large interference signal is superimposed on the direct signal. If the received signal is plotted as a function of frequency, as in a calibration measurement, the interference signal amplitude appears to be an inconsistent series of irregular sharp peaks and dips. A mathematical analysis of the condition where the transducers are midway between a water—air surface and a bubble-covered bottom shows that the shape, amplitude, and frequency of the interference pattern are predictable as the result of a large number of multireflection paths.

12945 DIFFRACTION OF PLANE SOUND WAVE BY MANY EQUAL CIRCULAR HOLES ARBITRARILY DISTRIBUTED IN AN INFINITELY LARGE RIGID PLANE PLATE.
Y.Nomura and T.Osanai.
J. Phys. Soc. Japan, Vol. 16, No. 4, 819-31 (April, 1961).

The solution of the problem, when the holes do not overlap but are distributed arbitrarily in one plane, is obtained by the method of expansion in hypergeometrical polynomials. Formulae of some physical quantities concerned are given. In the case of normal incidence, approximate formulae are given which are valid when the wavelength is large in comparison with the radius.

12946 ON THE DIFFRACTION OF SOUND WAVES IN A HEAT-CONDUCTING VISCOUS MEDIUM. J.B.Alblas.
Proc. K. Ned. Akad. Wetensch. B (Netherlands), Vol. 64, No. 3, 350-67 (1961).

This paper considers the diffraction by an infinitely thin screen of a sound wave which propagates in a gas of finite viscosity and heat conductivity. The screen is assumed to have an infinite heat conductivity and the sound wave is incident normally on the screen. It is assumed that the disturbance is small and that the equations may be linearized. Fourier transforms are then employed to reduce the boundary value problem to the solution of three pairs of dual integral equations. One of these pairs is such that it is amenable to solution by Wiener—Hopf methods and a formal solution is obtained. The necessary factorization, however, is not such that it can be expressed in terms of known functions. The remaining integral equations are of the type associated with simultaneous Wiener—Hopf integral equations and are not amenable to exact solution in a closed form. An approximate iterative procedure is adopted and the first term in the iterative scheme evaluated. The question of the uniqueness of the solution is examined and it is shown that the approximate solution obtained satisfies all the boundary conditions except that on the tangential velocity on the screen. The author states that this slip velocity will be small everywhere and that it is not necessary to consider the next term in the iterative solution of the integral equations. W.E.Williams

12947 AID TO MUSIC COMPOSITION EMPLOYING A RANDOM PROBABILITY SYSTEM.
H.F.Olson and H.Belar.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1163-70 (Sept., 1961).

The random probability system generates sequences of
in a series which are not completely random nor completely
ordered, but each note is selected in a random fashion with a
probability which depends upon preceding notes. Combined w
sound synthesizers, the machine provides additional instrum
for the musical laboratory.

12948 IMPEDANCE OF TAPERED STRUCTURES.
F.J.Young and B.H.Young.
J. Acoust. Soc. Amer., Vol. 33, No. 9, 1206-10 (Sept., 1961).

A general expression for the impedance of acoustical ho
and analogous devices is derived by considering a manifold o
uniform structures. The impedance of the manifold is obtain
complete mathematical induction and the impedance of a smo
varying tapered structure is obtained by a limiting process.
the expressions established here the impedances of acoustica
horns having mouth to throat area ratios ranging from 0.125 t
can be calculated with less than 10% error at zero frequency.

Instruments and Measurements

12949 COMMENTS ON "PRESSURE RESPONSE OF CONDENSER MICROPHONES AT LOW AMBIENT PRESSURES". F.Massa.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 810 (June, 1961).

See Abstr. 4417 of 1961. The main point made is that, in
to avoid variations in response which could cause serious err
in the measurement of sound pressure, it is necessary to use
measurement microphone in which the mechanical impedance
high and not subject to the influence of the air impedance ass
with a vibrating system. It is suggested that an ADP microph
would be suitable at low ambient pressures. B.

12950 STATEMENT IN ANSWER TO COMMENTS BY MR.MASSA ON OUR PAPER "PRESSURE RESPO
OF CONDENSER MICROPHONES AT LOW AMBIENT PRESSU
J.D.Chalupnik, E.Rule and F.J.Suellentrop.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 810 (June, 1961).

The authors agree substantially with Massa's comments,
point out that they merely wish to emphasize the difficulties i
condenser microphones at high altitudes in unsuitable conditio
They add that other types of microphone, as well as ADP mic
phones, are suitable at low ambient pressures. B.

12951 EFFECT OF HIGH-COUPLING COEFFICIENT ON
PERFORMANCE OF A MAGNETOSTRICTIVE TR
DUCER USED AS BOTH A PROJECTOR AND A HYDROPHON
G.L.Wilson and P.M.Kendig.
J. Acoust. Soc. Amer., Vol. 33, No. 7, 966 (July, 1961).

Shows that the divergence between the optimum condition
the transducer as a transmitter and as a receiver increases w
coupling coefficient. H.D.Pa

12952 COMMENTS ON "BASE PRESSURE FLUCTUATI
P.A.Franken.
J. Acoust. Soc. Amer., Vol. 33, No. 6, 813-14 (June, 1961).

See Abstr. 2803 of 1961. It is suggested that the scaling
argument used at the conclusion of Eldred's article to compa
laboratory measurements with measured vibration data repor
elsewhere is wrong, since the results derived are at variance
vibration data. The difference between laboratory and field da
subsequently suggested as being due to a number of effects pr
in the field and absent in the laboratory experiments. B.

12953 THE TELEMETRIC CHARACTERISTICS OF A PA
RECEIVING APPARATUS FOR MEASURING THE
DISTANCE OF A SOUND SOURCE. M.Federici.
Ricerca sci. (Italy), Vol. 30, No. 10, 2009-20 (Dec., 1960).
In Italian.

A theoretical investigation of the possibility of finding the
of a sound source by means of a linear array of microphones
outputs are fed to a central amplifier. Because of the phase
differences the amplifier output will depend on the range and
range can be estimated by the addition of artificial delay lines

ut variation is similar to that obtained when the arrangement sed for direction finding. T.S.E.Thomas

2954 OPTIMUM FREQUENCIES FOR ACTIVE SONAR DETECTION.

.Stewart, E.C.Westerfield and M.K.Brandon.

coust. Soc. Amer., Vol. 33, No. 9, 1216-22 (Sept., 1961).

The method of determination without knowledge of the absolute es of the sonar-set parameters, but only of their frequency endence, appears to have been originated by Horton in about 1945 and o be found in his recent text [Fundamentals of Sonar, United States al Institute, 317-24, 344-52 (1957)]. This theory has been simplified extended to include search rate, time-processing gain, and the io of echo-to-noise-plus-reverberation. The inclusion of these factors only slightly modifies the results obtained by maxi- zing echo-to-noise ratio alone because of the dominant effect of frequency dependent exponential attenuation term in the trans- ssion loss. Because of the octave or greater width of the maxima the lack of precision in the knowledge of the frequency depend- cies, the optimum frequencies should be looked on only as broad gions. For longer-range and hence lower-frequency active sonars erating at their optimum frequencies the energy of the pulse quired per unit area of volume searched increases rapidly with design range to a high exponent for the cases considered. This rollary is probably of little practical significance since the cost operating power is usually small compared to other costs.

oise . Architectural Acoustics

12955 NOTES ON SCALING JET AND ROCKET NOISE.

D.A.Bies and P.A.Franken.

Acoust. Soc. Amer., Vol. 33, No. 9, 1171-3 (Sept., 1961).

For dynamically similar systems it is shown that pressure ictuation amplitudes at similar positions are the same when easured in constant-percentage-frequency bands and when freq- ency is scaled inversely proportional to a characteristic length. is scaling relationship can be extended to systems containing oustic liners if the linear flow resistance is held constant. orrections for small errors in scaling are suggested for the case rocket engines.

12956 THE ORIGINS OF AERODYNAMIC NOISE.

N.Curle.

i. Progr. (GB), Vol. 49, 440-6 (July, 1961).

An attempt to reduce the theory of the generation of aerodynamic oise to the simplest possible terms. The discussion is essentially ysical, the important mathematical results being stated without oof.

12957 SOUND ABSORBING MATERIALS.

E.J.Evans and E.N.Bazley.

ondon: Her Majesty's Stationery Office (1960) 49 pp. [National hysical Laboratory].

The National Physical Laboratory has been engaged for many ears in the determination of the sound absorption coefficients of aterials in the specially designed reverberation chamber in the coustics Laboratory. A large number of proprietary materials ave been tested on behalf of industry. The measurements described cover most of the sound absorbents used in this country and e purpose of this booklet is to make the information available to sers and manufacturers. The data are also of scientific interest. ables are given showing the results of tests of 329 proprietary aterials, usually in the frequency range 125 to 4000 c/s. Ten bles include the following types: (1) acoustic plasters and granu- r materials; (2) fibrous materials; (3) wood wool materials;) expanded plastics and rubbers; (5) boards and panels; (6) perfor- ed tiles and boards; (7) perforated covers backed by absorbent;) floor coverings; (9) stone wall treatment; (10) miscellaneous aterials. The standard size of specimen used in each test was) ft × 10 ft, mounted in the chamber just as it would be in practice a building. A.B.Wood

OPTICS . PHOTOMETRY

12958 THE VELOCITY OF LIGHT IN A TRANSVERSE MAGNETIC FIELD.

R.V.Jones.

Proc. Roy. Soc. A (GB), Vol. 260, 47-60 (Feb. 7, 1961).

The alignment measurement technique previously developed for optical levers has been applied to an investigation of the constancy of the velocity of light in a transverse magnetic field in vacuo. The "noise" in the alignment measurements made has an r.m.s. value of about 2×10^{-11} rad, for an observing bandwidth of 1 c/s. The technique has been used to seek a change of direction of a light beam when traversing a "prism" of transverse magnetic field. No change in the velocity of light appears in a magnetic field of 8000 Oe, either for unpolarized light or for light plane polarized at 0, 45, or 90° to the magnetic field; the overall r.m.s. error of the investigation has been 2.3 parts in 10^{13}, or about 70 μ/s.

12959 LIGHT-PRESSURE TUBE.

H.V.Neher.

Amer. J. Phys., Vol. 29, No. 10, 666-8 (Oct., 1961).

A device for demonstrating the pressure of light is described. With present-day techniques it is not only possible to produce a gas pressure sufficiently low to reduce the radiometer effects to a negligible value compared with the light pressure effect, but it is also possible to maintain such a vacuum in a sealed-off tube for long periods of time.

12960 RADIATION PRESSURE ON A RAPIDLY MOVING SURFACE.

W.Rindler and D.W.Sciama.

Amer. J. Phys., Vol. 29, No. 9, 643 (Sept., 1961).

The authors derive an expression for the radiation pressure by tensor methods and point out an error in the result derived by Schlegel (Abstr. 19353 of 1960). See also following two abstracts. E.G.Knowles

12961 RADIATION PRESSURE ON A RELATIVISTICALLY MOVING MIRROR.

J.Terrell.

Amer. J. Phys., Vol. 29, No. 9, 644 (Sept., 1961).

An expression for the radiation pressure is derived by direct integration. An error is pointed out in the result derived by Schlegel. E.G.Knowles

12962 RADIATION PRESSURE ON A RAPIDLY MOVING SURFACE.

R.Schlegel.

Amer. J. Phys., Vol. 29, No. 9, 645 (Sept., 1961).

See two preceding abstracts. The author acknowledges the correction to his previous expression. E.G.Knowles

12963 THE GEOMETRY OF RADIATION.

J.Dourgnon.

Bull. Soc. Franc. Elect., Vol. 11, No. 15, 149-66 (March, 1961). In French.

The concepts of radiation luminance and intensity are defined precisely. A theorem due to Clausius is restated. A number of mathematical theorems, dealing with solid angles and of use in practical calculations, are given and applied to typical examples. R.W.Fish

12964 DIGITAL RECORDING ILLUMINATION PHOTOMETER.

W.Gründler.

Lichttechnik (Germany), Vol. 13, No. 5, 261-2 (May, 1961). In German.

A photovoltaic cell with a colour filter and a cosine-correcting mount is connected in a measuring circuit so that the cell is effectively short-circuited and the photocurrent is therefore proportional to the illumination. This current is fed into a digital recorder which indicates and records values of up to 1000 lux in steps of 1 lux. J.W.T.Walsh

DETERMINATION OF PORE STRUCTURE BY PHOTOGRAPHIC PHOTOMETRY. See Abstr. 12660

GEOMETRICAL AND INSTRUMENTAL OPTICS

SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

12965 OPTICAL IMAGE FORMATION IN TERMS OF ENTROPY TRANSFORMATIONS.

E.L.O'Neill and T.Asakura.
J. Phys. Soc. Japan, Vol. 16, No. 2, 301-8 (Feb., 1961).

Three major developments have been associated with problems in image formation optics in the last decade. They are the application of Communication and Information Theory concepts to optics, the theory of partial coherence and finally the matrix approach to image formation. In this report it is shown that these three developments are intimately related. Starting with Wolf's general theory of image formation in terms of the mutual coherence function (Abstr. 1653 of 1955), it is shown that both the matrix and communication approaches flow naturally from it. In addition, these latter two are themselves closely related. Finally, some new results showing the change in entropy loss as a function of focal position are presented both from a geometrical and physical optics point of view. The appeal is one of unity. The arguments presented are confined to the special but important case of quasi-monochromatic illumination. For sources of arbitrary spectral width and time varying fields, the generalized theory has not yet been fully developed.

12966 NOTE ON THE PROOF OF GABOR'S EXPANSION THEOREM.

K.Miyamoto.
J. Opt. Soc. Amer., Vol. 51, No. 8, 910-11 (Aug., 1961).

This note clarifies a point arising from the author's earlier paper (Abstr. 14791 of 1960). The latter draws conclusions from formulae which are only valid in the neighbourhood of the object. A more general discussion is given for the area between the object and the aperture and alternative formulae derived. R.W.Fish

12967 THE CONDITIONS AND METHODS OF RESOLVING TWO LIGHT SOURCES OF GREATLY DIFFERING INTENSITY.

O.M.Ryazanov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 634-9 (1959). In Ukrainian.

A criterion is formulated for a homogeneous slit objective. It is shown that by proper diaphragming of the aperture a substantial reduction of the intensity of subsidiary maxima may be attained, at the cost of a slight spreading of the zero maximum. This makes it practically possible to resolve two light sources of greatly differing intensity, which are not resolvable by means of a homogeneous objective.

12968 CLOSED SOLUTIONS OF RAYLEIGH'S DIFFRACTION INTEGRAL FOR AXIAL POINTS.

H.Osterberg and L.W.Smith.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1050-4 (Oct., 1961).

Rayleigh's diffraction integral is solved in closed form as regards all axial points when a divergent or a convergent spherical wave is specified as the electromagnetic disturbance incident upon a circular aperture or obstacle. Diffraction of divergent waves is treated briefly. The method is applied more fully to the diffraction of convergent waves by circular apertures. It is shown that the axial "focal point" of the converged spherical wave falls inside, at, or outside the geometrical focal point according as the angular semi-aperture θ_m of the lens is less than, equal to, or greater than a particular angle that falls near 70.5°. The magnitudes of the departures of the focal point from the geometrical focal point are illustrated by examples for both the radar and optical regions.

12969 REFLECTION OF RADIATION BY AN INFINITE PLANE ILLUMINATED WITH A POINT SOURCE. I. CHARACTERISTICS OF THE RADIATION FIELD.

B.A.Grigor'ev, A.G.Ershov and V.A.Uvarov.
Optika i Spektrosk. (USSR), Vol. 10, No. 1, 96-103 (Jan., 1961).
In Russian.

Gives characteristics of the radiation field for perfectly diffuse reflection and for directional reflection by an infinite plane when scattering in the medium above the plane can be neglected and only directional attenuation by the medium need be allowed for. [English translation in: Optics and Spectrosc. (USA), Vol. No. 1, 46-9 (Jan., 1961)]. A.Tybule

12970 PRIMARY ABERRATIONS OF MIRRORS.

A.S.Filler.
Amer. J. Phys., Vol. 29, No. 10, 687-94 (Oct., 1961).

The first approximation to the wave aberrations of a mirro found in a simple manner by comparing the figure of the mirror the figure of the surface which would give perfect imaging for th same conjugate foci. In order to introduce the various primary aberrations, the following cases are considered: (a) object and image on the axis of the mirror, (b) object and image equidistan from the mirror vertex, and (c) object at infinity. Three examp are worked out, discussing (1) the effect of a change of focus on spherical aberration, (2) the Newtonian telescope, and (3) the Schmidt camera.

12971 COMMENT ON A PAPER ON APODIZATION BY D.Yu.GAL'PERN.

J.E.Wilkins, Jr.
J. Opt. Soc. Amer., Vol. 51, No. 8, 911-12 (Aug., 1961).

See Abstr. 2848 of 1961. Gal'pern derived a relationship between the radius of the bright disk in the diffraction pattern of perfect system and one suffering from $\frac{1}{4}\lambda$ of spherical aberratio The present comment criticizes the hypotheses used in deriving these results and gives a more rigorous alternative derivation, which leads to the same result. R.W.

12972 THE EFFECT OF THE OBJECT THICKNESS ON PH CONTRAST.

R.Grigorovich [Grigorovici] and R.Manaila.
Optika i Spektrosk. (USSR), Vol. 10, No. 1, 113-19 (Jan., 1961).
In Russian.

Deduces relationships for illumination of the image of a pha object of finite thickness viewed through a phase-contrast micr scope. The effect of object thickness is important in the case of objectives with a large aperture and for objects whose width is comparable with their thickness and the wavelength of light. Th theoretical relationships were confirmed by experimental work. [English translation in: Optics and Spectrosc. (USA), Vol. 10, N 54-7 (Jan., 1961)]. A.Tybule

12973 FOCUSING PROPERTIES OF AN ACHROMATIC PARALLEL BEAM SHIFTING SYSTEM.

H.L.Vȳsots'kȳi, A.A.Kresnin and B.I.Tȳshchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 428-31 (1959).
In Ukrainian.

Considers some focusing properties of system proposed by Panofsky and Mcintyre (Abstr. 6674 of 1954).

12974 NEW MEASUREMENTS FOR THE DETERMINATION OF TRANSMISSION PROPERTIES OF OBJECTIVES FROM THE STANDPOINT OF TELEVISION TECHNIQUES.

D.Frenzel.
Hausmitt. Jos. Schneider (Germany), Vol. 12, No. 5-6, 64-72; No. 7-8, 90-6 (1960). In German.

In a television system, both the optics and the electronics influence the bandwidth of the complete system. The performan of the optical system can be defined by the limiting frequency wh is transmitted through a fixed bandwidth electronic system. An apparatus is described for determining this limiting frequency. Results for a number of lenses as a function of aperture and fiel angle are quoted. R.W.

12975 FIBER OPTICS. IX. WAVEGUIDE EFFECTS.

N.S.Kapany and J.J.Burke.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1067-78 (Oct., 1961).

For Pt VIII see Abstr. 2845 of 1961. In recent years techniq for fabricating fibres of diameter comparable to the wavelength have been developed in order to achieve high-resolution fibre opt systems. The performance of such fibres is analysed by using dielectric waveguide theory, and the results are interpreted fro the optical viewpoint of thin film interference and frustrated tota reflection. The energy distributions inside (mode pattern) and ou side such fibres are computed as a function of the fibre paramet and the interaction of energy between neighbouring fibres is considered. Experimental measurements of the fibre spread functio are made for assemblies of close-packed fibres, and its depende on fibre diameter (d), spacing (t), wavelength (λ), and indices of refraction (n_1 and n_2) is investigated. It is shown that the "optica ameter" of fibres and the number of modes propagated is critically pendent on the "fibre characteristic term" R given by

$$R = (\pi d/\lambda)\ (n_1^2-n_2^2)^{1/2}.$$

12976 TRANSMISSION PROPERTIES OF OPTICAL FIBERS.

R.J.Potter.

Opt. Soc. Amer., Vol. 51, No. 10, 1079-89 (Oct., 1961).

Equations which describe the flux transmitted and the angular stribution of the emergent light from straight cylindrical fibres of rcular cross-section are derived and numerically evaluated. Loss light due to imperfect reflections, bulk absorption, and Fresnel eflections, are included in the formulation. All skew rays in the bre are considered in these calculations. Measurements of the tenuation and angular distribution of the emitted light from plastic cintillating fibres were made. From the theoretical equations it as been deduced that these fibres are characterized by an internal eflectivity of 0.993 ± 0.002 and an absorption coefficient of .015 ± 0.003 cm^{-1}. Measurements of the light transmitted by ngle-clad glass fibres indicate that these fibres are characterized an internal reflectivity of 0.9993 ± 0.0002 and an absorption oefficient of the order of 10^{-4} cm^{-1}. Some experimental data on ass fibre bundles also are included.

12977 IMAGE-PROCESSING EXPERIMENTS.

D.H.Kelly.

. Opt. Soc. Amer., Vol. 51, No. 10, 1095-101 (Oct., 1961).

A technique is proposed for generalized spatial filtering with rge, incoherent light sources, making use of the photographic erschel effect. Outputs are obtained by a single exposure in a onventional optical printer; no scanning equipment, photographic asks or special developing processes are used. Exploratory xperiments with this technique are reported and desirable improvements are pointed out. Several different kinds of image processing or various applications are demonstrated.

12978 RESOLVING POWER OF CALCULATED AND DETECTED IMAGES.

V.Ronchi.

. Opt. Soc. Amer., Vol. 51, No. 4, 458-60 (April, 1961).

The resolving power of an instrument is not to be regarded as a haracteristic of the instrument itself, although one may use a conentional value such as the Rayleigh resolving power for convenience. practice, the achieved value depends upon the sensitivity characeristics of the receiver, on the energy conditions under which etection takes place and on other secondary factors. Acknowledgeent of these facts would eliminate misunderstanding in every day ractice. R.W.Fish

12979 METHOD FOR DETERMINING COMPARATOR SCREW ERRORS WITH PRECISION.

J.M.Bennett.

. Opt. Soc. Amer., Vol. 51, No. 10, 1133-8 (Oct., 1961).

A method is described for determining with precision the elative cumulative error and the periodic error of a comparator crew. Measured curves of these errors are shown for two omparators. The method also gives the relative lengths of the tervals on the scales used in the measurements.

12980 MULTIPLE-WAVELENGTH, MULTIPLE-BEAM INTERFEROMETRIC OBSERVATION OF FLAT URFACES.

D.R.Herriott.

. Opt. Soc. Amer., Vol. 51, No. 10, 1142-5 (Oct., 1961).

The use of multiple-beam interferometry makes it possible to bserve very small deviations in the flatness of optical surfaces. method is described which reduces the contour interval between ultiple beam fringes to between 1/20 and 1/100 wavelength. This ethod has been applied to the critical examination of a quantity Fabry-Perot plates for use in continuous helium-neon optical asers.

12981 AN EXPERIMENTAL STUDY OF AMPLIFICATION OF LIGHT USING A DEVICE CONSISTING OF A PHOTO-ESISTOR, A FERROELECTRIC AND AN ELECTROLUMINESCENT HOSPHOR.

I.N.Orlov and N.I.Taborko.

ptika i Spektrosk. (USSR), Vol. 9, No. 5, 626-30 (Nov., 1960). Russian.

Describes the circuit and the performance of an electrolumines-ent image amplifier in which a ZnS phosphor with green electro-uminescence is connected in series with a ferroelectric mono-rystal of triglycine sulphate. In parallel with them there is a dS-powder photoresistor which receives the incident light. With uch an amplifier weak light fluxes (of the order of 0.01 lux) can be amplified by a factor of 50 000. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 329-31 (Nov., 1960)].
A.Tybulewicz

12982 ULTRAVIOLET TRANSMITTING GLASS.

A.M.Bishay.

J. Opt. Soc. Amer., Vol. 51, No. 6, 702 (June, 1961).

Fused silica is known to have the best transmission at the bactericidal wavelength of 253.5 mμ but is expensive. The author has tested a number of alternatives, and shows that a glass having a molar composition 1.0 Al_2O_3, 4.5 B_2O_3, 1.0 K_2O melted in a reducing atmosphere is superior to all except fused silica. R.W.Fish

RATE OF REMOVAL OF MATERIAL IN GRINDING OPTICAL GLASS. See Abstr. 12727

12983 COMPARISON OF INFRARED TRACKING SYSTEMS.

A.R.Gédance.

J. Opt. Soc. Amer:, Vol. 51, No. 10, 1127-30 (Oct., 1961).

Compares the rotating-reticle tracking system with two variants of the conical-scan system. It is shown that the accuracy of rotating-reticle system is inherently limited by the size of the target image, and that the conical-scan systems have no similar limitation. For target acquisition, however, the rotating-reticle system is found to be superior.

12984 A NON-SELECTIVE OPTICO-ACOUSTIC RECEIVER WITH A CAPACITOR MICROPHONE.

N.A.Pankratov and É.F.Vasil'ev.

Optika i Spektrosk. (USSR), Vol. 10, No. 1, 127-30 (Jan., 1961). In Russian.

A receiver with a capacitor microphone was constructed using the established fact that the threshold sensitivity of selective and non-selective optico-acoustic receivers is independent of the type of microphone used in them. The receiver threshold sensitivity was greatest at low frequencies, where it was practically the same as the sensitivity of a receiver with an optical microphone. The amplifier circuit for use with the receiver is described. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 61-3 (Jan., 1961)]. A.Tybulewicz

12985 HIGHLY PRECISE WAVELENGTHS IN THE INFRARED. II. HCN, N_2O, AND CO.

D.H.Rank, D.P.Eastman, B.S.Rao and T.A.Wiggins.

J. Opt. Soc. Amer., Vol. 51, No. 9, 929-36 (Sept., 1961).

For Pt I see Abstr. 842 of 1961. A discussion is given of the effect of mechanical errors in a grating drive on the accuracy with which line frequencies can be measured. It is shown that it is highly improbable that a mechanical device used to rotate a diffraction grating can be constructed with sufficient precision so that the line-frequency error will be determined by the optical information observable in the near infrared spectrum. By making use of the echelle spectrograph 67 lines of the 001—000 absorption band of HCN were measured. Almost 400 lines from five N_2O absorption bands arising from the ground state of the molecule were also measured. In addition, 11 lines from the 1—0 fundamental band of CO were measured in order to determine ν_0 for this band. In all cases only those band lines were measured which appear to be free of blends. The molecular constants of the above bands were determined by making use of the combination relationships, applying least-squares methods to the data. The line frequencies were then calculated to four decimal places and presented in tables. The tables contain over 600 line frequencies. It is believed the calculated line frequencies (lines free of blends) have an absolute accuracy of about 1 part in 5 × 10^6 and a relative accuracy referring to lines within a given band somewhat greater.

12986 INFRARED ANALYSERS AND THEIR APPLICATION FOR THE AUTOMATION OF PRODUCTION PROCESSES.

A.F.Mal'nyev and L.S.Kremenchuhs'kÿ̄i.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 277-92 (1959). In Ukrainian.

Consider the working principles of infrared analysers and their application to process control. The classification of analysers is based on the means of effecting selectivity. The analysers are subdivided into dispersive and non-dispersive. A comparative evaluation is made of the operation of analysers with a positive filter or selective receiver, a negative filter or non-selective receiver, and a tri-non analyser, as well as of dispersive analysers of the spectrometer, spectrophotometer, many-channel and many-point type. The principal optical diagrams and the recording circuits of non-dispersive analysers are described. A method is discussed for "sensitizing" non-dispersive type analysers to a single component. The problems solved by means of infrared analysers are enumerated, and their field of application is outlined. Bibliography of 154 items.

12987 OPTICAL SPECTROSCOPY.
A.C.Menzies.
Research (GB), Vol. 14, No. 7, 285-92 (July, 1961).

The need for greater speed in analysing metals has promoted the design and manufacture of automatic spectrographs, which use radiation of wavelengths in the visible, ultraviolet and vacuum ultraviolet regions. Absorption spectra are measured in the ultraviolet and infrared regions; both may be employed for analyses of organic materials, while infrared is particularly useful for structural investigations.

12988 A SERVO-METHOD FOR PRODUCING EQUAL-QUANTA, EQUAL-ENERGY, OR EQUAL-RESPONSE SPECTRA.
R.M.Hill, R.Oechsli and E.Marg.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1139-41 (Oct., 1961).

A servo-method is described which can provide any type of spectral energy distribution desired for biological or physical experiments, by installation of the appropriate empirically determined cam. A grating monochromator driven by a reversing motor provides a continuous spectrum which may be scanned repeatedly at selected band widths, the visible range being traversed in 15 sec with a maximum error of plus or minus 3%. Also the system can be made to produce spectra which elicit responses of arbitrarily fixed magnitude from retinal preparations, equal-response spectra. The results would be in terms of deviation from an equal-energy, equal-quanta, or any other type of chosen spectrum depending on the cam employed. This servo-method has the advantage of immunity to the ageing of lamps and filters and permits replacement of a defective lamp by another of the same or of an entirely different type without calibration being required. An alternative to the use of mechanical cams, intended to produce similar results employing the photoformer principle, also is described briefly.

12989 RECTIFICATION OF PHOTOELECTRIC SPECTROMETER. K.W.Ostrowski.
Acta phys. Polon. (Poland), Vol. 19, No. 3, 319-27 (1960).

Formulae are derived for the tolerances in focusing and slit inclination. A practical method of adjusting slit inclination using a Hartmann diaphragm is described. The permissible height of the exit slit is calculated for both linear and curved slits. For photoelectric photometry, these results show that high slits and high 45° prisms have an advantage. R.W.Fish

12990 USE OF TWO POLARIZING COMPONENTS IN PRISM OR GRATING SPECTROMETERS. E.Charney.
J. Opt. Soc. Amer., Vol. 51, No. 8, 912 (Aug., 1961).

An anomaly can occur when intensity is measured through two polarizing components used in series in spectrographic instruments. Calculations and experiment show that for a typical prism instrument the angle of maximum transmittance can be −8° instead of 0°, although the minimum is still at 90°. R.W.Fish

12991 EMPLOYING MAGNESIUM OXIDE AS A DIFFUSE REFLECTOR IN SPECTROPHOTOMETRIC RESEARCHES. M.D.Borȳsov and V.N.Vȳshnev'skȳi.
Ukrayin.fiz. Zh. (USSR), Vol. 3, No. 1, 88-94 (1958). In Ukrainian.

The effect is investigated of the reflectance of magnesium oxide on the spectral intensity distribution in a beam emerging from a 50 mm sphere, the walls of which are covered with a thick layer of the oxide. The experiments were carried out at room temperature and at liquid nitrogen temperature. It was found that the slight absorptivity of the oxide cannot be neglected with multiple reflection. In the case of the present sphere containing two screens on the inside, it was found that the light underwent 20-30 reflections from the walls before it emerged. The multiplicity of the reflections has a great effect on the spectral intensity distribution in the emergent beam. Moreover, the reflectance of powdered magnesium oxide does not depend on temperature in the range 300-90°K. The results indicate that, on comparing the intensity of beams of different spectral composition emerging from a photometric sphere, the difference in the reflectance of magnesium oxide in these spectral regions must be taken into consideration. The fact that the diffuse reflectance of powdered magnesium oxide does not depend on temperature, establishes a reason for employing it as a diffuse reflector not only at room temperature, but at lower temperatures as well.

12992 THE APPLICATION OF MAGNESIUM OXIDE IN SPECTROPHOTOMETRY. V.N.Vȳshnevs'kȳi.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 629-33 (1959). In Ukr

For previous work, see preceding abstract. A study was
of the efficacy of applying magnesium oxide as a diffuse refle
integral spectrophotometers for the region 0.45-1.03 μ. The
iple-reflecting capacity of oxide applied to the inner surface o
50 mm red copper sphere was investigated in this region of th
spectrum. It was shown that, on photometrizing the intensitie
monochromatic beams of various spectral composition in this
of the spectrum (as in the ultraviolet region), the dependence
multiple reflecting capacity of MgO on wavelength must be tak
into account. It is also shown that, in this region of the spectr
the reflecting capacity of magnesium oxide remains unchanged
kept for a long time in air having a relative humidity of 45-50
and does not depend on the substrate when the thickness of the
layer is 1.5 mm. The experiments were conducted at room te
rature. The single reflecting capacity of MgO in the region
0.28-1.03 μ is calculated from the results obtained.

12993 NANOSECOND LIGHT SOURCES.
G.Porter and E.R.Wooding.
J. photogr. Sci. (GB), Vol. 9, No. 3, 165-71 (May-June, 1961).

The sources described are powered by small capacitors o
short transmission lines. Light flashes have been obtained wh
have half-peak durations of 8 to 50 nanosec. Energies of > 0.1
have been discharged. Factors influencing flash duration are
cussed. E.R.W

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

12994 METHOD FOR DETERMINING THE OPTICAL CONSTANTS OF THIN, EVAPORATED FILMS IN T
FAR ULTRAVIOLET REGION. D.Fabre, J.Romand and B.Voda
J. Phys. Radium (France), Vol. 21, No. 4, 263-4 (April, 1960). In French.

By plotting the reflectivities at various points of the film,
whose thickness varies in a known manner along its length, aga
the distances of these points from one end, an oscillating curve
obtained from which the complex refractive index can be deduc
The method does not involve a knowledge of the substrate const
E.A.Mu

12995 INTERFERENCE LIGHT FILTERS WITH A TRANSMISSION BAND OF 1.5 A WIDTH.
F.A.Korolev, A.Yu.Klement'eva and T.F.Meshcheryakova.
Optika i Spektrosk. (USSR), Vol. 9, No. 5, 648-52 (Nov., 1960). In Russian.

Multilayer filters with a narrow transmission band, down t
1.5 A, were prepared by alternate evaporation of ZnS and cryol
in vacuum. The maximum transmission was only 15% in the 1.5
bands. [English translation in: Optics and Spectrosc. (USA),
No. 5, 341-3 (Nov., 1960)]. A.Tybule

12996 REAL FRINGES IN THE SAGNAC AND MICHELSON INTERFEROMETERS.
A.Zajac, H.Sadowski and S.Licht.
Amer. J. Phys., Vol. 29, No. 10, 669-73 (Oct., 1961).

In describing the Michelson interferometer, it is usually st
that in order to observe fringes an extended source must be use
It has to be realised, however, that this requirement applies onl
the formation of virtual fringes. Actually two distinct sets of
fringes exist; virtual and real. Rarely, if ever, is attention bro
to the existence of the latter type. The existence of the real fr
was first noted by the authors using the Sagnac interferometer,
which is described in this paper. This little-known interferome
and the Michelson interferometer are both amplitude-splitting
types. Real fringes were obtained for both a point source and a
extended source while virtual fringes were, of course, only visi
for an extended source. Similar sets of real fringes were also
observed for the Michelson interferometer using either an exter
or a point source. An analysis of the formulation of real fringes
presented.

2997 SPATIAL COHERENCE IN THE OUTPUT OF AN OPTICAL MASER. D.F.Nelson and R.J.Collins.
ppl. Phys. (USA), Vol. 32, No. 4, 739-40 (April, 1961).

Reports the successful performance of Young's double slit eriment with the coherent 6943 A radiation output of a ruby er. This represents the first time that this experiment has performed with a coherent source. Predicted and measured t intensities agreed to within 20%. The slit separation was 541 cm (centre to centre). Thus, spatial coherence of the ation over a distance of about 100 wavelengths has been shown. e interference pattern, separate streaks side by side appeared he photographic film. Each streak contained the expected rference fringes. It is shown that each streak was the result of fferent area along the slits undergoing maser action. A typical neter of such an area was about 0.05 cm. Below the maser eshold, the ruby fluorescence emerging from the slits produced nterference pattern. P.M.Parker

2998 SIMPLE SCHLIEREN DEMONSTRATION. C.L.Mason.
er. J. Phys., Vol. 29, No. 9, 642-3 (Sept., 1961).

Describes a method of demonstrating schlieren phenomena g a point source of light and a pinhole in place of the more al knife edges. By this means it is claimed to be easy to in good results. Practical details are given. E.G.Knowles

12999 OBSERVATION IN THE YEAR 1648 OF DIFFRACTION THROUGH A LATTICE. J.Marek.
ure (GB), Vol. 190, 1092-3 (June 17, 1961).

An account of a work by Ionnes Marius Marci of the University Prague in which he dealt with the orgin and qualities of the nbow and "fictitious" (spectral) colours. Although without rect knowledge of the causes he described the colours of the tes and diffraction by wire, edge, aperture and through a lattice.

13000 AN EXPERIMENTAL STUDY OF THE SPECTRAL DISTRIBUTION OF THE INTENSITY OF POLARIZED HT DIFFRACTED BY A GRATING.
.Yakovlev and F.M.Gerasimov.
tika i Spektrosk. (USSR), Vol. 10, No. 1, 104-12 (Jan., 1961).
Russian.

Reports a study of reflection of monochromatic polarized light a large number of diffraction gratings ruled on thin metal layers e profiles were stepped). The spectral distributions of the fracted light were displaced relative to one another in the two es of the electric vector of incident light parallel and normal the grating lines. The distribution for the electric vector allel to the grating lines was always displaced towards shorter velengths and the displacement was proportional to the wavelength inversely proportional to the grating constant. The displacement duced a change in the polarization of the diffracted light plotted inst wavelength. Replica gratings made of polymethyl methaylate or gelatine did not exhibit this displacement. [English nslation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 50-4 n., 1961)]. A.Tybulewicz

FRAUNHOFER DIFFRACTION OF AN ELECTROMAGNETIC VE. See Abstr. 13181

13001 DETERMINATION OF THE OPTICAL CONSTANTS OF ABSORBING MATERIALS FROM MEASUREMENTS OF OKES PARAMETERS FOR REFLECTED LIGHT. A.P.Prishivalko.
tika i Spektrosk. (USSR), Vol. 9, No. 4, 493-500 (Oct., 1960).
Russian.

Stokes parameters are four-dimensional vectors which give intensity and polarization of a light beam. The four components a Stokes parameter can be measured experimentally. The author lates the Stokes components to components of a three-dimensional larization vector P_i, and derives relationships between P_i, the tical constants and the angle of incidence. Nomograms are given determination of the optical constants from values of P_i and the gle of incidence. [English translation in: Optics and Spectrosc. SA), Vol. 9, No. 4, 256-9 (Oct., 1960)]. A.Tybulewicz

13002 REFLECTION AND REFRACTION OF LIGHT IN OPTICALLY-ACTIVE ISOTROPIC MEDIA.
V.Bokut' and F.I.Fedorov.
tika i Spektrosk. (USSR), Vol. 9, No. 5, 635-9 (Nov., 1960).
Russian.

Gives an exact calculation of polarization of light reflected from an optically active isotropic medium or from a cubic crystal, and shows that the reflected wave has a maximum ellipticity for any angle of incidence when the incident wave is linearly polarized parallel or at right angles to the plane of incidence. At a certain intermediate azimuth of the incident-wave vibrations, the reflected wave is linearly polarized. It is shown that within an interval of several angular seconds near a certain angle of incidence (close to the Brewster angle) at the zero azimuth of the incident-wave vibrations, the reflected-wave polarization changes very sharply from circular to linear and again to circular with the opposite sense of rotation. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 334-6 (Nov., 1960)]. A.Tybulewicz

FARADAY EFFECT IN MOLECULES. See Abstr. 12297

COLORIMETRY . PHOTOGRAPHY

13003 SOME MEASUREMENTS OF THE EFFECT OF AIR TURBULENCE ON PHOTOGRAPHIC IMAGES.
E.Djurle and A.Bäck.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1029-1030 (Sept., 1961).

Experimental measurements of the effect of air turbulence upon the image of a distant object are described. The contrast transfer (CT) function was measured by an electrophotometer for a 36" focal length f/6.3 lens imaging a slit-shaped light source over a ground distance of seven miles. Some correspondence between meteorological conditions and the value of the CT function was found. Under the conditions of measurement, the deterioration in imaging properties caused by air turbulence may be the limiting factor on performance. N.Murcott

NANOSECOND LIGHT SOURCES. See Abstr. 12993

13004 LINE-SPREAD FUNCTIONS OF PHOTOGRAPHIC EMULSIONS. N.W.Lewis.
Nature (GB), Vol. 189, 909 (March 18, 1961).

The line-spread function, $B(x)$, obtained by measuring (on an intensity-scale) the variation of photographic blackening in the image of a narrow slit printed down onto a photographic emulsion, is commonly used to evaluate the ability of the photographic emulsion to record fine detail. In such work, the "double-exponential" function, $B(x) = \pi F \exp(-2\pi F|x|)$ is converted to the Fourier transform to yield the sine-wave response function, $Y(f) = 1/\{1 + (f/F)^2\}$ where f is the spatial frequency, and F is the value of f such that $Y(F) = 0.5$. When plotted this function yields a discontinuity at $Fx = 0$, and possesses other disadvantages. To overcome these difficulties, it is proposed to represent the line-spread function by a "fourth-power cosine" function having the form, $B(x) = 2AF/\pi\{1 + (AFx)^2\}^2$ where $A = 3.7437$, when expressed in terms of the parameter F. There is then no central discontinuity; and, although both functions yield substantially similar results at the lower frequencies, the new function yields a more rapid fall of sine-wave response at the higher frequencies — a desirable feature in practice. D.R.Barber

IMAGE-PROCESSING EXPERIMENTS. See Abstr. 12977

HEAT . RADIATION

13005 MATHEMATICAL TREATMENT OF A FOUR-COMPONENT FURNACE. M.J.Laubitz.
Canad. J. Phys., Vol. 39, No. 6, 951-5 (June, 1961).

Presents temperature distribution formulae derived for a quite general four component furnace with cylindrical symmetry. It is assumed that the thermal conductivity of each component is independent of temperature. H.Morrison

PROGRESS IN CRYOGENICS. See Abstr. 13029

13006 FLASH METHOD OF DETERMINING THERMAL DIFFUSIVITY, HEAT CAPACITY, AND THERMAL CONDUCTIVITY.
W.J.Parker, R.J.Jenkins, C.P.Butler and G.L.Abbott.
J. appl. Phys. (USA), Vol. 32, No. 9, 1679-84 (Sept., 1961).

A flash method of measuring the thermal diffusivity, heat capacity, and thermal conductivity is described for the first time. A high-intensity short-duration light pulse is absorbed in the front surface of a thermally insulated specimen a few millimetres thick coated with camphor black, and the resulting temperature history of the rear surface is measured by a thermocouple and recorded with an oscilloscope and camera. The thermal diffusivity is determined by the shape of the temperature versus time curve at the rear surface, the heat capacity by the maximum temperature indicated by the thermocouple, and the thermal conductivity by the product of the heat capacity, thermal diffusivity, and the density. These three thermal properties are determined for copper, silver, iron, nickel, aluminium, tin, zinc, and some alloys at 22° and 135°C and compared with previously reported values.

13007 A NOTE ON HEAT TRANSFER AND FILM BOILING.
R.D.Rao,H.S.Desai and D.V.Gogate.
Indian J. Phys., Vol. 34, No. 10, 456-60 (Oct., 1960).

Heat transfer between electrically heated metal wires and different boiling liquids was studied and characteristic boiling curves were obtained by plotting the heat flux q/A against the excess of temperature Δt of the wire over the boiling point. The relation between the heat transfer coefficient h and Δt was also studied. The values of maximum heat flux and critical temperature difference are calculated for the different wires and liquids used in this investigation.

KAPITZA THERMAL RESISTANCE AT SOLID—LIQUID HELIUM BOUNDARY. See Abstr. 13036

13008 EXACT ELECTRIC ANALOGY TO THE VERNOTTE HYPOTHESIS. C.W.Ulbrich.
Phys. Rev. (USA), Vol. 123, No. 6, 2001-2 (Sept. 15, 1961).

The Fourier equation of heat conduction predicts the paradoxical result that the effect of a thermal impulse in an infinite medium will be felt instantaneously in all parts of the medium. In other words, a thermal impulse is propagated at infinite velocity. The result is paradoxical because it is incompatible with a dynamic interpretation of the mechanism of heat transfer in solids. In order to avoid this apparent paradox, Vernotte has proposed (Abstr. 6900 of 1958) a modification of the Fourier hypothesis. This modification results in the transformation of the equation of heat conduction from a parabolic to a hyperbolic differential equation predicting finite velocity of propagation of thermal impulses. Vernotte's proposal is shown here to have an exact electric analogy. The proposal is equivalent to postulating the existence of a heat transfer quantity which is analogous to the electric inductance. The transformed equation of heat transfer is therefore analogous to the differential equation of telegraphy.

HEAT CONDUCTION BY LIQUID HELIUM II IN CAPILLARY TUBES. TRANSITION TO SUPERCRITICAL CONDUCTION. See Abstr. 13035

13009 THERMOELASTIC EQUATIONS AND GRUENEISEN'S RELATION. A.M.Freudenthal.
J. appl. Phys. (USA), Vol. 32, No. 9, 1801-2 (Sept., 1961).

Shows that the consideration of Grueneisen relation (1908) resolves an apparent inconsistency that arises in the conventional approach to the transient thermoelastic problem when the heat-transfer equations are solved independently of the elastic equations of motion. J.K.Skwirzynski

13010 THERMAL EXPANSION OF TECHNICAL SOLIDS AT LOW TEMPERATURES. A COMPILATION FROM THE LITERATURE. R.J.Corruccini and J.J.Gniewek.
Nat. Bur. Stand. (USA), Monogr. No. 29, 22 pp. (1961).

Tables are given of the linear contraction relative to 293°K, $(L_{293}-L_T)/L_{293}$, and the linear expansion coefficient, $dL/L_{293}dT$, of thirty elements, forty-five alloys, twenty-two other inorganic substances and twenty plastics and elastomers in the temperature range, 0° to 300°K.

13011 COMMENTS ON "DIELECTRIC BOLOMETER".
R.Hanel.
J. Opt. Soc. Amer., Vol. 51, No. 8, 916 (Aug., 1961).

The comments arise from (Abstr. 4499 of 1961), and record the properties of a similar system built by the University of Chicago. In addition, a reference to earlier work is given. R.W.Fish

13012 APPARATUS FOR MEASURING THE PARAMETERS RADIATION DETECTORS.
A.F.Mal'nyev and L.S.Kremenchuhs'kyi.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 522-3 (1959). In Ukraini

13013 A LOW-TEMPERATURE RECEIVER OF THERMAL RADIATION. A.F.Mal'nev and L.S.Kremenchugskii.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 530-1 (Oct., 1960). In Russian.

Describes a low-temperature bolometer made of nickel and filled with liquid nitrogen. The threshold sensitivity was twenty times lower at 77°K than at 300°K, and other parameters were a better at 77°K. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 278 (Oct., 1960)]. A.Tybule

COMPARISON OF INFRARED TRACKING SYSTEMS. See Abstr. 12983

13014 COLOR TEMPERATURE DIAGRAM.
B.R.Canty and G.P.Kirkpatrick.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1130-2 (Oct., 1961).

13015 STAGNATION TEMPERATURE MEASUREMENTS IN HYPERSONIC WIND-TUNNEL USING THE SODIUM LINE REVERSAL METHOD. J.L.Stollery.
Nature (GB), Vol. 190, 778-9 (May 27, 1961).

Temperatures, around 1500°K, were measured in the bow shock wave of a blunt body. The tendency of the reversal metho give the effective vibrational temperature, together with real temperature gradients and heat losses, cause the measured valu to be about 350 degrees low. Limits of piston materials prevent temperatures in excess of 2000°K being achieved in the gun tunn The effects of a damping plate are examined. A.G.Ga

13016 METHOD OF MAKING SMALL POINTED THERMOCOUPLES. C.M.Stover.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 366-8 (March, 1961).

Describes a method of making "probe" thermocouples of sm diameter (0.005 in. or less) with correspondingly low thermal capacity and rapid response time. The technique adopted for obtaining concentric conductors, electrically insulated except at tip, could be useful in other applications. E.G.Kno

13017 OVENS FOR THERMAL TREATMENT [OF METALS AND ALLOYS] IN VACUUM. I.V.Salli.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 128-9 (Nov.-Dec.). In Russian.

The constructional details of two types are described and sh diagrammatically. The samples are heated to temperatures of t order of 1000°C and tempered in either mercury or vacuum oil. first type is a vertical furnace, but the second is held horizontal during the heating of the sample. [English translation in: Instr exper. Tech. (USA), No. 6, 984-6 (Nov.-Dec., 1959; publ. Sept., 1960)]. S.Weint

13018 COMPACT HIGH-TEMPERATURE VACUUM FURNA
S.B.Austerman.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 924-5 (Aug., 1961).

A small furnace is heated by electrical resistance in a refractory metal tube which is surrounded by radiation shields a a water-cooled housing arranged in a compact assembly. The heater tube can be replaced readily without disassembling the furnace. The furnace can be heated to a temperature of 2200°C or higher in vacuum or nonoxidizing atmosphere.

13019 FAST RESPONSE, LOW INERTIA VACUUM FURNA
L.H.Rachal.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 940-2 (Aug., 1961).

The furnace possesses the following characteristics: (1) lo actual thermal mass, allowing rapid temperature change when desired; (2) high effective thermal mass, resulting in precise te erature control; and (3) minimum gas evolution. In the range 150°-950°C, the maximum temperature deviation is approximate 0.1°C; the mean deviation is less than 0.05°C.

SIMPLE APPARATUS FOR THE GENERATION OF PRESSURES ABOVE 100 000 ATMOSPHERES SIMULTANEOUSLY WITH TEMPERATURES ABOVE 3000°C. See Abstr. 12731

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

13020 **INVESTIGATION OF THE CRITICAL STATE OF MATTER BY TOEPLER'S METHOD. I. EXPERIMENTAL**
OCEDURE. O.T.Shy̆mans'ka.
rayin. fiz. Zh. (USSR), Vol. 3, No. 4, 542-51 (1958). In Ukrainian.

The present study is devoted to the development of a procedure r studying the change in density of substances in the critical ate. Toepler's method was employed for this purpose. The present thor developed (1) the optical part of the set-up, a bomb with plane rallel optical glasses, which makes it possible to study substances th a critical temperature up to 300°C and a critical pressure up 100 atm, and (2) a vacuum thermostat, which can maintain a con- nt temperature with an accuracy of 0.001°C or change it at any en rate by means of a programmed thermoregulating device. veral graphs are given of the density gradient distribution of ethyl er along the height of the bomb at various temperatures. The aphs were obtained at a rate of heating of 1 deg/hr. The tentative nclusion is drawn that the critical state of matter is realized at at is practically a point.

13021 **INVESTIGATIONS OF THE CRITICAL STATE OF MATTER BY TOEPLER'S METHOD. II. DEPENDENCE**
F THE DENSITY OF HEXANE ON THE TEMPERATURE IN THE
IGHBOURHOOD OF THE CRITICAL POINT.
Z.Holy̆k and O.T.Shy̆mans'ka.
rayin.fiz. Zh. (USSR), Vol. 4, No. 6, 769-87 (1959). In Ukrainian.

For Pt I, see preceding abstract.

13022 **VAPORIZATION OF THE RARE EARTH OXIDES.**
M.B.Panish.
chem. Phys. (USA), Vol. 34, No. 6, 2197-8 (June, 1961).

This further study (see Abstr. 8263 of 1961) shows that the rare-rth sesqui-oxides may be divided into two groups within each of ich the vaporization mode changes abruptly from $M_2O_3 \rightarrow 2\,MO(g) +$)(g) to $M_2O_3 \rightarrow 2\,M(g) + 3\,O(g)$. The abrupt change occurs after in the one group and after Yb in the other. It is noted that this assification (except for Lu_2O_3) is identical with that of the rare rths into so-called cerium and yttrium groups. W.Good

13023 **VAPOR PRESSURE OF ANTIMONY BY THE TORSION-EFFUSION METHOD.**
M.Rosenblatt and C.E.Birchenall.
chem. Phys. (USA), Vol. 35, No. 3, 788-94 (Sept., 1961).

The pressures and mean molecular weights of the vapours er solid antimony (420-550° C) and solid zinc (250-335° C) were termined by simultaneous measurements by the torsion-momentum d Knudsen weight loss methods, The torsion measurement was librated with mercury at 30° C using a mercury vapour pressure of 96 × 10^{-3} mm Hg determined by concurrent weight loss experi- nts. Zinc vapour is confirmed to be monoatomic. The zinc essure data is represented by $\log P_{mm} = (8.741 \pm 0.218) -$ 630 ± 125)/T giving $\Delta H_{298}{}^{\circ}$ (vap) = 30.73 ± 0.57 and .18 ± 0.12 kcal/mole by the second law and third law of thermo- namics, respectively, in excellent agreement with previously ported results. The vapour over solid antimony is all Sb_4 mole- les within experimental error. Least-squares analysis of the timony data yields $\log P_{mm} = (10.571 \pm 0.090) - (10\,300 \pm 68)/T$, essures 10%-40% lower than those previously reported. The at of vaporization of $Sb_4(g)$ at 298.16° K is 49.83 ± 0.31 kcal/mole the second law and 49.45 ± 0.09 by the third law of thermo- namics. This thermodynamic consistency and the agreement of zinc results with accepted measurements indicate that the anti- ony pressures presented should be preferable to those previously ported.

13024 **VAPOR PRESSURES OF THE INERT GASES.**
C.E.Hamrin, Jr and G.Thodos.
chem. Phys. (USA), Vol. 35, No. 3, 899-902 (Sept., 1961).

A single vapour-pressure relationship applicable from the iple point to the critical point has been found to exist for the inert ses argon, krypton, and xenon when the reduced vapour pressure R is related to T_R the reduced temperature. This vapour-pressure nction resulted from the Frost—Kalkwarf equation and can be expressed as

$$\log P_R = \alpha + (\beta/T_R) + \gamma \log T_R + 0.1832\,(P_R/T_R^2),$$

where 0.1832 is a universal constant. For these inert gases $\beta = -2.2936$ and $\gamma = -2.6786$ while α can be calculated from the boundary condition, $\alpha + \beta + 0.1832 = 0$. The vapour-pressure data for helium and neon produced similar reduced-vapour-pressure relationships having different constants, These results are not unexpected in view of the significant quantum effects associated with helium and to a lesser degree with neon. Values calculated with this reduced-vapour-pressure equation have been found to be in excellent agreement with experimental values reported for argon, krypton, and xenon. The average deviation for these gases was 0.63%, for neon 1.51%, and for helium 0.79%.

13025 **MASS SPECTROMETRIC STUDY ON THE EVAPORATION OF VOLATILE COMPONENTS IN POLYETHYLENE.** K.Nakagawa.
J. Phys. Soc. Japan, Vol. 16, No. 4, 741-5 (April, 1961).

Many ions were observed in the spectra of polyethylene heated in the ion source of a mass spectrometer for the temperature range of 150°-330°C. With elevation of temperature, the rate of ionic yield displayed a stage of slower increase, Process I, followed by a steeper uprise, Process II. For two commercially available samples of polyethylene, Marlex and Hostalen, it was found that the values of activation energy for the latter stage appeared to be 34 kcal mol^{-1} for Marlex and 24.7 kcal mol^{-1} for Hostalen. On the contrary, the values for Process I were found to be 6.5 ± 1.2 kcal mol^{-1} for both samples. According to the mass spectra obtained and the values of activation energy, it was concluded that Process II corresponds to the stage of thermal degradation, while Process I would be explained by the presence of a stage of evaporation of lighter components included originally in polyethylene.

13026 **LAW OF CORRESPONDING STATES FOR FUSED SALTS.** H.Reiss, S.W.Mayer and J.L.Katz.
J. chem. Phys. (USA), Vol. 35, No. 3, 820-6 (Sept., 1961).

Reduced equations of state are developed for strictly ionic salts through an analysis of the configuration integral. In this way, appropriate laws of corresponding states are developed for vapour pressures, surface tensions, and melting points. Agreement between theory and experiment is satisfactory for a large class of salts.

13027 **INVESTIGATION OF THE DENSITY OF A SUBSTANCE [ETHYL ETHER] NEAR THE CRITICAL STATE BY THE GAMMA-RAY ABSORPTION METHOD.**
A.Z.Holy̆k and V.M.Kazans'ky̆i.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 670-6 (1959). In Ukrainian.

THERMODYNAMICS

(See also Statistical Mechanics)

13028 **A USEFUL THERMODYNAMIC DIAGRAM.**
H.Schenck, Jr.
Amer. J. Phys., Vol. 29, No. 10, 703-4 (Oct., 1961).

Using the equations for the efficiency of a heat engine and the coefficient of performance of a refrigerator, it is shown that a diagram constructed of straight lines can express the heat flows, efficiencies, coefficients of performance, and work terms of such devices. The diagram may also be used for Carnot-type machines when temperatures of the heat sources and sinks are given. A hypothetical system is shown in schematic and plotted on the diagram.

NEGATIVE ENTROPY AND PHOTOSYNTHESIS.
See Abstr. 12703

LOW-TEMPERATURE PHYSICS

13029 PROGRESS IN CRYOGENICS. VOLUME 3.

Edited by K.Mendelssohn.
London: Heywood (1961) 173 + vii pp.

Contains 6 review articles and preface. Abstracts of the articles will appear in this or succeeding issues of Physics Abstracts. J.B.Birks

CRYOSTAT FOR IRRADIATING AT 4.2°K. See Abstr. 13030

13030 CRYOSTAT FOR IRRADIATING AT 4.2°K.

A.Sosin and H.H.Neely.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 922-4 (Aug., 1961).

In this device, it is possible to irradiate samples with no intervening foils, to measure at 4.2°K, to study annealing in situ to over 100°K, and to achieve recovery beyond 350°K. A sample holder utilizing the high thermal conductivity of copper and sapphire is discussed.

Liquid and Solid Helium

13031 THE DETECTION OF SINGLE QUANTA OF CIRCULATION IN LIQUID HELIUM II. W.F.Vinen.

Proc. Roy. Soc. A (GB), Vol. 260, 218-36 (Feb. 21, 1961).

An apparatus if described for detecting single quanta of superfluid circulation round a fine wire in liquid helium II. The wire is stretched down the centre of a cylindrical vessel containing helium, and the circulation may be established by rotating the whole apparatus about the axis of the wire and cooling from above the λ-point. The wire can be set into transverse vibration, and the circulation round it can then be obtained from the rate of precession of the plane of vibration. The technique proves to be sufficiently sensitive for the measurement of circulations of order h/m with an accuracy of about 3%. The method in its present form measures only an average of the circulation along the length of the wire, and it is found that this average is not quantized. Apparent circulations equal to a fraction of a quantum are attributed to quantized vortices that are attached to only a fraction of the length of the wire, and this interpretation has been confirmed by showing that an apparent circulation of exactly h/m has much greater stability than any other value. In this way the quantization of superfluid circulation in units of h/m has been experimentally verified. Observations made in the course of this work show clearly that superfluid circulations (including free vortex lines) can persist indefinitely even when the rotation of the apparatus is stopped. Values have also been obtained for the circulation round the wire as a function of the angular velocity of rotation, and it is shown from these that the energy of a free vortex line in the helium surrounding the wire may perhaps be considerably smaller than has hitherto been supposed.

13032 THE INFLUENCE OF PRESSURE ON THE MOBILITY OF ELECTRIC CHARGES IN LIQUID HELIUM II.

S.Cunsolo and P.Mazzoldi.
Nuovo Cimento (Italy), Vol. 20, No. 5, 949-55 (June 1, 1961).

The mobility of positive and negative charges in liquid helium II was measured as a function of the pressure, for pressures ranging from the vapour pressure to the melting point, in the temperature range 1.9 to 1.1°K. The mobility of the positive charges was found to decrease with the increasing pressure, but this decrease cannot be accounted for in terms of the known change in the roton density. The negative charges behave in a peculiar way which can be easily accounted for by the bubble model. For both charges an unexplained sharp break is found at about 1.3°K especially at the higher pressures.

13033 TRANSFER OF THE UNSATURATED HELIUM II FILM.

D.F.Brewer and K.Mendelssohn.
Proc. Roy. Soc. A (GB), Vol. 260, 1-12 (Feb. 7, 1961).

The critical transfer rate was measured on surfaces of glass and german silver by a heat conduction method. It is found that a considerable reduction of the transfer rate occurs when the vapour pressure over the film is decreased only slightly below the saturation value. At a given percentage of the saturation pressure, there exists a critical temperature above which film flow will not take place. This critcal temperature is shown to be sharply defin to decrease with decreasing percentage saturation. At the ful saturation pressure the transfer rate is markedly different o various surfaces used, but as the vapour pressure over the fi decreases the flow rate tends to become the same for all surf The critical temperature for onset of superfluidity is also ind ent of the substrate. The temperature dependence of the tran rate is different from that for the saturated film, but very si to the variation found in the flow of liquid through channels of less than that of the saturated film.

13034 HEAT TRANSFER BETWEEN SOLIDS AND LIQU HELIUM II. L.J.Challis, K.Dransfeld and J.Wilk

Proc. Roy. Soc. A (GB), Vol. 260, 31-46 (Feb. 7, 1961).

Measurements have been made of the thermal boundary resi between liquid helium II and copper, lead and quartz, also betwee copper and liquid helium II at different densities. It is found the dependence of the heat flow on the density of the heliu markedly different from that predicted by Khalatnikov (195 According to this author, the transfer of heat from the sol surface to the helium takes place by the radiation of phonons, as would be the case between two dielectric solids. However, Khalatnikov does not take account of the fact that the layer of close to the solid has a much higher density than the bulk liqui analysis has been made of the effect of this dense layer, and t dependence of the heat flow on the density of the bulk helium f be much closer to that observed experimentally. The experim results using different solid materials suggest that, in metals least, some other mechanism of heat transfer may be involve

13035 HEAT CONDUCTION BY LIQUID HELIUM II IN CAPILLIARY TUBES. I. TRANSITION TO SUPE CRITICAL CONDUCTION. D.F.Brewer and D.O.Edwards.

Phil. Mag. (GB), Vol. 6, 775-90 (June, 1961).

Measurements were made of the heat conduction by liquid helium II in capillary tubes of diameter 52.0 μ, 107.6 μ and 36 The results on subcritical flow have been described previousl the present paper is concerned with observations in the transi region to supercritical conduction. Outstanding features of the transition are (i) spontaneous fluctuations in the thermal resis (ii) very large hysteresis effects in the resistance at low temp tures in the wide tubes, which decrease as the lambda point is approached, and which depend on the previous history of the he and (iii) sensitivity of the thermal resistance to mechanical sh or vibration, including permanent changes from one branch of hysteresis loop to the other. The observations, which include measurements of the critical velocity, as a function of tube si and temperature, are discussed in terms of the vortex line the of Feynman and its development by Vinen (Abstr. 6119 of 1957; 154, 3041 of 1958), which are found to give good agreement wit experiments.

13036 UNIMPORTANCE OF SURFACE ROUGHNESS UPO THE KAPITZA RESISTANCE. W.A.Little.

Phys. Rev. (USA), Vol. 123, No. 6, 1909-11 (Sept. 15, 1961).

A proof is given which shows that surface roughness whic less than the phonon mean free path can only increase the Kap resistance between liquid helium and a solid; and that this cha in resistance is small. (The Kapitza resistance is the therma resistance which gives rise to the discontinuous jump in temp ture observed at the solid—liquid interface when a solid is hea while immersed in liquid helium).

13037 LIFETIME EFFECTS IN CONDENSED FERMION SYSTEMS. A.Bardasis and J.R.Schrieffer.

Phys. Rev. Letters (USA), Vol. 7, No. 3, 79-81 (Aug. 1, 1961).

An integral equation for the energy gap at $T=0^{\circ}$K is obtain using a Green's function method which includes finite-lifetime effects. The effects of damping on this equation are considere Damping lowers the possible critical temperature T_c of liquid the value $T_c=8\times10^{-4}$ °K being obtained using a seperable effect two-body potential. T.

13038 GENERALIZED BARDEEN—COOPER—SCHRIEFF STATES AND THE PROPOSED LOW-TEMPERAT PHASE OF LIQUID He^3. P.W.Anderson and P.Morel.

Phys. Rev.(USA), Vol. 123, No. 6, 1911-34 (Sept. 15, 1961).

Particle interactions in a Fermi gas may be such as to att pairs near the Fermi surface more strongly in l = 1, 2, 3 or h states than in the simple spherically symmetrical s state. In t case the Bardeen—Cooper—Schrieffer condensed state must be

alized, and the resulting state is an anistropic superfluid.
uthors studied the properties of this type of state in consider-
letail, especially for l = 1 and 2. Expressions were derived
e energy, the moment of inertia, the magnetic susceptibility
ie specific heat. The density correlation function and the
y-current density correlation were also derived; in some
the latter implies that the liquid has net surface currents and
orbital angular momentum. The ground state for l = 2 is
ent from those previously considered, and has cubic symmetry
o net angular momentum. A general method for replacing the
oly rather complicated potential by a simple scattering matrix
en. A brief discussion of possible collective effects is
led. The results were applied to liquid He^3; after correction
cattering by a method due to Suhl, it was found that the
cted transition should take place below 0.02°K. Other possible
cations are suggested.

039 NEW ALLOTROPIC FORM OF He^3.
A.F.Schuch and R.L.Mills.
. Rev. Letters (USA), Vol. 6, No. 11, 596-7 (June 1, 1961).
Ie^3, like He^4, changes from hexagonal close-packed to face-
ed cubic at high pressure. At 18.7°K and 1690 atm,
4.24 A. The transition pressure lies between 1341 and 1690
A.R.Stokes

perconductivity

040 SIMPLE MODEL FOR THE MAGNETIC BEHAVIOR OF SUPERCONDUCTORS OF NEGATIVE SURFACE
RGY: B.B.Goodman.
. Rev. Letters (USA), Vol. 6, No. 11, 597-9 (June 1, 1961).
The thermodynamic properties of a superconductor whose
rence distance is less than the penetration depth and which has
tive surface energy is discussed. It is shown that magneti-
on persists to a high value of the magnetic field if the negative
ace energy is large: this should occur for very impure super-
uctors. The model is compared with some experimental
lts. D.J.Thouless

3041 EFFECT OF MAGNETIC FIELD ON THERMAL CONDUCTIVITY AND ENERGY GAP OF SUPER-
DUCTING FILMS. D.E.Morris and M.Tinkham.
s. Rev. Letters (USA), Vol. 6, No. 11, 600-2 (June 1, 1961).
Thermal conductivity is measured in superconducting films
function of the applied magnetic field, and the results are
rpreted in terms of the behaviour of the energy gap in a field.
thin films the transition to the normal state appears to be of
nd order, but it is of first order for thicker films. The con-
ivity does not depend on whether the field is parallel or
endicular to the heat flow, although theory suggests that it
ld. An initial decrease in the conductivity as the field is
eased for one of the samples is interpreted in terms of a
ease in the phonon conductivity. D.J.Thouless

3042 EXPERIMENTAL EVIDENCE FOR QUANTIZED FLUX IN SUPERCONDUCTING CYLINDERS.
Deaver, Jr, and W.M.Fairbank.
s. Rev. Letters (USA), Vol. 7, No. 2, 43-6 (July 15, 1961).
See following three abstracts.

3043 EXPERIMENTAL PROOF OF MAGNETIC FLUX QUANTIZATION IN A SUPERCONDUCTING RING.
ll and M.Näbauer.
s. Rev. Letters (USA), Vol. 7, No. 2, 51-2 (July 15, 1961).
Two experiments showing that the flux through a hollow super-
ucting tube (about 10^{-3} cm in diameter) is quantized in units
c/2e, within experimental error. Deaver and Fairbank
ceding abstract) used a tin tube, plated onto a copper wire, and
ced the flux from the e.m.f. induced in a nearby search coil
the tube was vibrated; Doll and Näbauer used a lead tube,
orated onto quartz and suspended horizontally from a torsion
, and deduced the flux from the amplitude of oscillations induced
a transverse field was applied at the resonant frequency of
system. See following two abstracts. R.G.Chambers

3044 THEORETICAL CONSIDERATIONS CONCERNING QUANTIZED MAGNETIC FLUX IN SUPERCONDUCT-
CYLINDERS. N.Byers and C.N.Yang.
s. Rev. Letters (USA), Vol. 7, No. 2, 46-9 (July 15, 1961).
See following abstract.

13045 MAGNETIC FLUX THROUGH A SUPERCONDUCTING RING. L.Onsager.
Phys. Rev. Letters (USA), Vol. 7, No. 2, 50 (July 15, 1961).

Two brief theoretical discussions of the observed quantization. Quantization in units of hc/2e, instead of hc/e as originally predicted by London, is attributed to the pairing or superconducting electrons. R.G.Chambers

13046 SPECIFIC HEATS OF SOME CUBIC SUPERCONDUCTING TITANIUM—MOLYBDENUM ALLOYS BETWEEN 1.1 AND 4.3°K. R.R.Hake.
Phys. Rev. (USA), Vol. 123, No. 6, 1986-94 (Sept. 15, 1961).

The specific heats of four b.c.c. Ti—Mo alloys were measured between 1.1° and 4.3°K, and at atomic fractional Mo concentrations between 0.0625 and 0.0860 (sufficient to stabilize the b.c.c. phase). The normal state molar specific heats can be represented by the usual expression $C_n = \gamma T + \beta T^3$, where it is commonly assumed that $\gamma \propto N(E_F)$, the energy density of electronic states at the Fermi energy, and $\beta \propto \theta_D^{-3}$. For each of the alloys the apparent electronic superconducting state specific heat for $1.3 < (T_c/T) < 2.6$ can be represented as $C_{es}/\gamma T_c = a \exp(-bT_c/T)$, where a=10.5, b=1.52, and the superconducting transition temperature, T_c, is taken as the midpoint of the rather broad (~0.45 K°) superconducting transition. The measured values of T_c, θ_D, and γ are all rapidly varying and nearly linear functions of atomic fractional Mo concentration, f. At the mean solute concentration (f = 0.0742): T_c = 2.59°K, $d \ln T_c/df = +16.7$; θ_D = 337°K, $d \ln \theta_D/df = -6.2$; γ = 5.45 millijoules/mole $(K^0)^2$, $d \ln \gamma/df = = d \ln N(E_F)/df = +7.7$. On the basis of the Bardeen—Cooper—Schrieffer theory of superconductivity, the relative variations of T_c, θ_D, and $N(E_F)$ indicate that the electron—electron interaction parameter of that theory, A, is a relatively slowly varying function of solute concentration ($d \ln A/df = -3.0$).

13047 PERSISTENT RING CURRENTS IN AN IDEAL BOSE GAS. J.M.Blatt.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 82-3 (Aug. 1, 1961).

The currents are found to exist on cooling below the Bose—Einstein transition temperature in an external magnetic field which is then removed. It is shown that on removing a ring from the field the final magnetic flux through the ring may differ appreciably from an integral number of "flux quanta". It is concluded that an energy gap is not necessary for the existence of such currents in a superconductor where the "bosons" are attractively correlated electron pairs. T.Burke

ELECTRICITY

ELECTRICAL MEASUREMENTS AND CIRCUITS

13048 RESISTANCE AS DISSIPATION INTO MANY REACTIVE CIRCUITS: LANDAU DAMPING AND NYQUIST'S NOISE THEORUM. O.Buneman.
J. appl. Phys. (USA), Vol. 32, No. 9, 1783 (Sept., 1961).

By considering nonradiative dissipation as the irreversible dispersal of energy into a large number of degrees of freedom it is shown that it is possible to simulate resistance by a large number of purely reactive elements. The result assists the understanding of Landau damping in a plasma and also enables a quick deduction of Nyquist's formula. D.Llanwyn-Jones

13049 CONTACTLESS RESISTIVITY METER FOR SEMICONDUCTORS. J.C.Brice and P.Moore.
J. sci. Instrum. (GB), Vol. 38, No. 7, 307 (July, 1961).

The resistivity of specimens in the range of 10^{-3} to 10 ohm cm was determined by means of eddy currents which were induced in them by a 10 Mc/s oscillator. The latter consisted of a cathode follower coupled to a grounded-grid amplifier with zero static bias. The presence of the test specimen caused a drop in Q of the oscillatory circuit, which in turn was measured as a potential difference between the anode leads of the two valves. The method is accurate to ~5% and has the advantage of being independent of the surface preparation and geometry of the specimens so long as certain readily realizable geometrical conditions are fulfilled.
R.Parker

13050 SENSITIVITY ERROR IN FREQUENCY MEASUREMENTS WITH THE WIEN BRIDGE. H.H.Wolff.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 902-5 (Aug., 1961).

The limitation in the null instrument sensitivity of bridges leads to errors which are due to the uncertainty in the null adjustment. This paper deals with this sensitivity error in Wien frequency bridges. Formulae for the relative error in frequency measurement and for optimum bridge parameters are derived. The influence of deviations from the optimum parameters is shown and discussed. It is shown that, for bridges covering a wide frequency range, certain free parameters should be made adjustable to maintain good sensitivity.

13051 ELECTRONIC DETERMINATION OF THE I, G AND I/G PARAMETERS OF A TUNNEL DIODE. C.R.Gneiting.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 907-8 (Aug., 1961).

To design a minimum noise-figure tunnel-diode r.f. amplifier, the point of minimum $I/|G_d|$ ratio must be known. Also of importance in the design are the diode bias current required at this point of minimum $I/|G_d|$ ratio and the conductance obtained at this bias point. A scheme is described whereby X—Y recordings of the I—V, G—V, and I/G—V curves for a tunnel diode can be obtained.

13052 STABILIZED POWER SUPPLY OF HIGH QUALITY EMPLOYING TRANSISTORS.
E.Baldinger and W.Czaja.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960), p. 329-33

In a shunt type regulator it was possible, by using a transistor thermostat, which contained the reference voltage and a symmetrical preamplifier, to obtain a stabilization factor of 6000. The output voltage was continuously variable from 1 to 17 V, and the maximum load current is 2.5 A at 1 V, or 0.8 A at 17 V. The internal resistance was about 10^{-4} ohm at d.c. W.G.Stripp

13053 TRANSISTORIZED REACTOR INSTRUMENTATION AND PROTECTIVE CIRCUITS.
R.R.Hoge and D.J.Niehaus.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 335-45.

A block diagram is given for a complete monitoring and protection system in which transistors are largely used. Circuits are given for a log-power amplifier, a period amplifier, a power level amplifier, a bistable trip circuit and for the transistor control of safety rod latch magnets. W.G.Stripp

13054 NEW TRANSISTOR CIRCUITS IN PROSPECTING APPARATUS. L.Hugolin and C.Lallemant.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 349-59. In French.

The factors causing variation of the current gain are examined. The parameters determining the gain are (a) the collector current, which depends on temperature, (b) the output resistance, which is also dependent on temperature, and (c) the input resistance. Variations of (a) and (b) can be reduced by feedback, while the effect of (c) can be minimized by means of an inductance between the base and the emitter, using the common collector arrangement. Some experimental amplifier and monovibrator circuits which gave good stability are described. W.G.Stripp

13055 A TRANSISTORIZED EQUALIZER FOR FAST COINCIDENCE WORK WITH SCINTILLATION COUNTERS. R.V.Gåsström.
Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 377.

A p—n—p transistor is used as a limiter in the last dynode circuit of a photomultiplier. By making leads short and building the transistor into the termination of the output coaxial cable, it was possible to achieve time resolutions of about 1 mμs. W.G.Stripp

13056 A MEDIUM-RATE COINCIDENCE CIRCUIT.
J.A.Pajares.
An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 56 A, No. 9-10, 243-8 (Sept.-Oct., 1960). In Spanish.

A coincidence circuit with a variable resolving time between 0.2 and 1 μsec, employing the dual-control tube 6BN6, is described. Curve showing amplitude ratio between coincidence and single output pulses versus 6BN6 plate load is given. Coincidence pulse height as a function of time between input pulses is shown.

13057 FAST COINCIDENCE SYSTEM BASED ON A TRA ORIZED TIME-TO-AMPLITUDE CONVERTER.
P.C.Simms.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 894-7 (Aug., 1961).

The time-to-amplitude converter is designed for time ma ments in the range 10^{-7} to 10^{-11} sec. The time resolution of system is defined as the full width at half maximum of the a distribution produced by the time converter in response to p coincidence events. The best time resolution obtained was 4 $\times 10^{-10}$ sec. The time converter and all the accessory circu described.

13058 "BOXCAR" INTEGRATOR WITH LONG HOLDING TIMES. R.J.Blume.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1016-18 (Sept., 1961

The bipolar output of the r.f. phase detector of the recei nuclear magnetic resonance pulse experiment is fed through 4 diode sampling switch to an RC integrator, whose output is r recording electrometer. The switch (a "transmission gate") two type 7266 ceramic thermionic diodes, whose back resista extremely high ($> 10^{12}\,\Omega$ at −50 V). The Mylar integrating ca therefore, discharges so slowly between successive sampling that the typical holding time with a 0.01-μf capacitor is ~ 10 A simple method is given for using the "boxcar" as a sampli oscillograph for slowly and automatically plotting the entire b input signal as it is seen on a cathode ray oscilloscope, but w noise integrated out. There is a detailed discussion of circui components, and performance.

ELECTROSTATICS . DIELECTR

(The study of solids through their dielectric propertie is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

13059 EFFECT OF SURFACE CHARGE IN ELECTRIFIC MEASUREMENTS. J.C.Ingraham and S.F.Philp.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1032-3 (Sept., 1961)

Although the volume charge distribution in a homogeneou substance decays exponentially with time, in general this will not be true of the electric field above a free surface of the su due to the formation of surface charge. This must be taken i account in using the electric field or the surface potential as measure of the electrification, or the decrease of these quan as a measure of the time constant of a charged sample. The tion of surface charge during charge relaxation is considered simple one-dimensional case. The contribution made by surf charge to the surface potential and electric field above the su may be large if a grounded object, such as a probe or field m is near the surface.

CURRENT ELECTRICITY
ELECTROKINETICS

(The study of solids through their electrical conductio properties is included under Solid-State Physics)

13060 HIGH CURRENT STEP GENERATOR.
E.S.Weibel and I.R.Jones.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 972-4 (Aug., 1961).

A circuit is described for the generation of current step functions of long duration, having a short rise-time and yieldi large steady current. The following set of values has been ac rise time, 1 μsec; duration, 320 μsec; current, 5000 A.

13061 THERMAL RESPONSE OF BRIDGEWIRES USED ELECTROEXPLOSIVE DEVICES. L.A.Rosenthal
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1033-6 (Sept., 1961)

The thermal equations for a bridgewire or equivalent ele explosive device are presented. When sinusoidal current pas through such a thermally sensitive resistance, it is capable o generating a third harmonic voltage which is a measure of th ability to follow the instantaneous cycling power fluctuations.

ing the variation of this third harmonic with frequency it is e to determine the thermal time constant.

2 NOTE ON THE MEASUREMENT OF THE FIGURE OF MERIT OF THERMOELECTRIC MATERIALS AND OF GERATING JUNCTIONS. G.J.B.Crawford.
i. Instrum. (USA), Vol. 32, No. 3, 353-4 (March, 1961).
rapid method is described that uses no vacuum system and oldering iron as a heat source. It is based on the Harman (Abstr. 1492 of 1959) and for materials of low thermal conduct- capable of an overall precision of 5%. P.A.Walker

IONIZATION

63 DETECTION OF FREE CHARGES FROM MOTÓR-CAR EXHAUST GASES. T.Westermark.
(GB), Vol. 189, 910 (March 18, 1961).
an investigation of the part played by unipolar radical ions ation chemistry and in the intitiation of lung cancer, measure- were made with a portable charge collector of free charges in -car exhaust gases and from other sources. The output of the ment was proportional to the concentration of charge in the Charges were found in the exhaust gas cloud, often about 10^7 s/cm^3. In the worst case, the current was 10^{-4} A, whereas ds" produced only 10^{-9} A, or slightly more than a cigarette. e concentrations were also found on the pavements of streets eavy traffic and in the back seats of cars driving behind diesel . Starting a car in a garage fills the space rapidly with a concentration which, however, drops in some tens of seconds car leaves the garage. R.Schnurmann

64 ELASTIC AND INELASTIC SCATTERING OF LOW-VELOCITY H^+ AND H_2^+ IN HYDROGEN, W.H.Cramer.
m. Phys. (USA), Vol. 35, No. 3, 836-8 (Sept., 1961).
ross-sections were measured in the energy range 4 to 400 eV astic scattering and charge exchange of H^+ and H_2^+ ions in gen. The results are compared with similar measurements uterium ions in deuterium. Charge exchange was observed he entire energy range for H_2^+, but was detected only above for H^+. Constants for empirical potential functions are ated and tabulated.

65 DISSOCIATIVE ELECTRON CAPTURE IN WATER VAPOR. G.S.Hurst, L.B.O'Kelly and T.E.Bortner.
Rev. (USA), Vol. 123, No. 5, 1715-18 (Sept. 1, 1961).
n electron swarm experiment was conducted to study the ss of negative-ion formation in water vapour by dissociative on capture. Assuming that electrons are captured in a single ss at one well-defined energy, the present results are consist- th a beam experiment reported by Buchel'nikova (Abstr. 1119 9). It was found that the capture cross-section (due to the tion of H^-), when integrated over energy, was 7.7 × ^{18} cm^2 eV, which is consistent with the electron beam results × 10^{-18} cm^2 eV. The energy at which the process peaks was to be 6.4 eV, which agrees quite well with the peak energy by Buchel'nikova, but in general disagrees with other values ed by mass spectroscopy.

66 DYNAMICS OF IONIZED GASES.
B.Steginsky.
. J. Phys., Vol. 29, No. 9, 605-16 (Sept., 1961).
he dynamics of a classical, ionized gas is presented in a way stresses the role of individual particles in contributing to the behaviour of the gas. An important distinction is drawn en a weakly ionized and a strongly ionized gas, and it is shown e latter, through long-range interaction forces, exhibits the menon of collective behaviour. Three methods of description yed in the study of ionized gases are reviewed. These are the scopic theory, the velocity-distribution method, and the scopic theory. Part of the section on the macroscopic theory oted to a consideration of the special case of a perfectly cting gas in order to illustrate typically the pitfalls which may countered in a narrow application of the continuum approach gnetohydrodynamics.

13067 THE EFFECT OF THE ORIENTATIONS OF ELECTRIC MAGNETIC FIELDS ON THE ELECTRON MEAN ENERGY AND DRIFT VELOCITY IN A PARTIALLY IONIZED GAS.
C.-S.Wu.
Proc. Roy. Soc. A (GB), Vol. 259, 518-30 (Jan. 24, 1961).

The electron velocity distribution function relating to the presence of the external fields with arbitrary orientations is first studied. The analysis is based on the Lorentz approximation and it is assumed that the electron velocity distribution is determined essentially by the electron-atom collisions. The mean electron energy is discussed for two different cases: (1) constant mean free path and (2) constant collision time. In the case of constant collision time, the drift velocity as well as the electron current density is calculated. The Hall conductivity is expressed in a general form which depends upon the direction of the magnetic field with respect to the electrical field. Besides this, an additional component of the current is theoretically observed; in general, it vanishes if the magnetic field is either parallel or perpendicular to the electric field.

13068 DETERMINATION OF THE DRIFT VELOCITY OF ELECTRONS IN GAS MIXTURES.
A.Comunetti and P.Huber.
Helv. phys. Acta (Switzerland), Vol. 33, No. 8, 911-32 (1960).
In German.

A description is given of a method suitable for the precise calculation of the drift velocity of electrons in gas mixtures. The method provides a simultaneous determination of the diffusion coefficients and also assuming cylindrical symmetry the calculation of the electron temperature relative to the gas temperature. The apparatus used is an alpha-particle ionization chamber and a "start-stop" method is described. The principle gases used were $A-N_2$ and $A-CO_2$ mixtures. Reproducibility of results was generally better than 0.5%; E/p values were determined to 1%. Results are given for E/p values from 0.1 to 1.0 V cm^{-1} mm^{-1} Hg and show that for certain gases the drift velocity passes through a maximum. The velocity is greater in mixtures than in the separate gas components. H.Edels

13069 ON THE THEORY OF DE-IONIZATION OF RAREFIED GAS IN A MAGNETIC FIELD.
A.S.Sÿrgii and V.L.Granovskii.
Radiotekhnika i Elektronika (USSR), Vol. 5, No. 7, 1129-34 (July, 1960). In Russian.

A theory is developed of de-ionization processes of rarefied gas in a cylindrical container placed in a homogeneous magnetic field parallel to the axis of the container. Remanent plasma is assumed isothermal. Diffusion and volume recombination of charged particles are taken into account. Derived equations are applied to an illustrative example of helium at 0.06 - 0.33 mm Hg, in a magnetic field of 0 - 1500 G. J.M.Silberstein

13070 CHARGE EXCHANGE BETWEEN POTASSIUM IONS AND ATOMS. R.M.Kushnir.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 343-50 (1958). In Ukrainian.

The effective cross-sections of resonance charge exchange were measured by the retarding field method and the method of slow ion extraction in the energy range of 6 to 656 eV. The experimental curve of the dependence of the charge-exchange cross-section on the ion velocity decreases steadily toward the region of high velocities. The values of the charge-exchange cross-section at medium velocities proved to be lower than those calculated from the boundary formula of Sena (1943) and higher than those obtained theoretically by Firsov (Abstr. 5261 of 1952). However, Firsov's theoretical curve is a good representation of the dependence of the charge-exchange cross-section on the ion velocity.

ELECTRIC DISCHARGES

13071 ON INVESTIGATIONS OF LINEAR IMPULSE DISCHARGES.
W.Frie, H.Maecker, A.Michel, H.Motschmann and H.Schindler.
Z. Naturforsch. (Germany), Vol. 16a, No. 1, 121-6 (Jan., 1961).
In German.

A linear impulse discharge system was used comprising a condenser bank of 1030 μF charged to 15 kV with a self inductance of 4×10^{-9} H. The discharge was initiated in a cylindrical chamber of 38 cm diameter and 45 cm high when current rates of 1.5×10^{12}

A/sec were obtained. Drum camera records of the luminosity and spectra of the discharges in deuterium and hydrogen were obtained for pressures from 0.03 to 3 torr. The records show at first a luminosity of the whole discharge cross-section followed by a dark phase and then the phase of contraction. The discharge distributed over the whole cross-section of initiation was displaced to the wall by skin effect and then forced to the axis by the Lorentz forces. The spectra show, particularly with the higher pressures, intensive continua during the contractions to which later the line emissions of the wall material are added. By probe measurements the extent of symmetry in an axial direction was determined and it is concluded that eddy currents on the axial plane must exist. Below 6×10^{-2} torr X-ray and neutron radiation occur. X-ray emission of 100 kV (equivalent) voltage was registered during each contraction as well as an impulse on initiation. A neutron impulse of more than 10^{7} neutrons was observed after the second contraction and simultaneously with the helical instability. H.Edels

13072 EXPERIMENTS ON THE POSITIVE COLUMN IN A LONGITUDINAL MAGNETIC FIELD. F.C.Hoh.
Ark. Fys. (Sweden), Vol. 18, Paper 31, 433-41 (1960).

The abnormal diffusion of the positive column in a longitudinal magnetic field observed by Lehnert [Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, Vol. 32 (1958) p. 145] was investigated with a new apparatus and with improved techniques. The measurements confirm earlier results and extend these to a wider range of pressures, discharge currents, magnetic fields, and to different gases. The experimental method was checked by a number of tests. The noise in the discharge current and the ion current to electric probes inserted in the plasma indicate a transition of the state of the discharge and an enhancement of the diffusion rate. This occurs near the critical magnetic field observed in earlier measurements on the potential gradient. Some features of the abnormal diffusion phenomenon are discussed on the basis of observations.

13073 A NOTE ON THE CROSS-SECTION OF THE LUMINOUS DISCHARGE CHANNEL IN A GLOW DISCHARGE.
K.D.V.Nagamani and V.T.Chiplonkar.
Indian J. Phys., Vol. 35, No. 3, 128-34 (March, 1961).

The variation in the cross-section x and the half-width radius (h.w.r.) of a luminous discharge channel was studied for different points in the cathode dark space of a glow discharge in hydrogen and air. Results show that: (1) the cross-section x reaches a minimum value at some distance Z in front of the cathode; (2) the value of the minimum cross-section as well as its location in the cathode dark space is a function of the pressure; (3) both the h.w.r. and x decrease with decreasing pressure for the range 400-252 μ 100-150 μ. For lower pressures the variation of the two parameters is opposite in character.

13074 ON THE ELECTRICAL BREAKDOWN OF ARGON AT HIGH PRESSURE. G.List.
Beitr. Plasma Physik (Germany), Vol. 1, No. 3, 137-52 (1960-61). In German.

Using breakdown fields of over 10^{5} V/cm, deviations were observed from Paschen's Law in argon at pressures up to 300 atm. Plane parallel electrodes were used of various metals (Ni, Au, Al and Zn). The deviation can be characterized by a constant c which depends on the electrode material, the properties of the cathode surface and the ratio of the breakdown field to the gas pressure. The breakdown at high pressure can be explained as a field emission effect in which the necessary field strength is produced by the deposit of positive gas ions on the oxidized cathode surface. In competition with this is a charge compensation because of the conductivity of the oxide layer. The two processes explain the magnitude of the constant. From the equilibrium of the two processes an equation for the static breakdown potential is derived. K.W.Sturgess

13075 ELECTRICAL CONDUCTION AND BREAKDOWN IN HIGH-PRESSURE (0.25-300 mm) RARE GASES.
R.Forman.
J. appl. Phys. (USA), Vol. 32, No. 9, 1651-8 (Sept., 1961).

The current—voltage characteristics of high pressure (0.25-300 mm) rare gas diodes were measured. Data were taken on diodes containing xenon, argon, and helium as the ambient gas and tungsten, tantalum, rhenium, thoriated tungsten, and an oxide cathode as filamentary cathodes. Some unexpected phenomena were observed and some of these general results can be summarized as: (1) The current versus voltage characteristics of argon- and xenon-filled diodes, at gas pressure above 1 mm, do not obey any sp charge law if the cathode temperature is above 2400°K. (2) T violation of space-charge relations in argon- and xenon-fille odes is found with tungsten, tantalum, or rhenium filaments, can be operated above 2400°K. When thoriated tungsten or th cathode, which operate below 2400°K, are used as filaments, current—voltage characteristics of the diode follow a space- relation (current—voltage characteristics independent of tem ture). (3) The current—voltage characteristics of helium-fill odes, however, do obey the space-charge relations at all fila temperatures available with the present cathode materials. (4) Some very unusual early breakdown phenomena (breakdow potentials below ionization potential) were observed in these pressure rare-gas diodes employing a hot cathode. These da be explained qualitatively by postulating the existence of ther generated xenon or argon gas ions at temperatures in the ran 2400°K. An attempt will be made to justify this assumption b semi-quantitative theoretical treatment based on Saha's therm ionization theory rather than the surface ionization theory of muir and Kingdon.

ELECTROSTATIC POTENTIAL GRADIENTS IN A PENN DISCHARGE. See Abstr. 13088

PLASMA

(See also Magnetohydrodynamics)

13076 RELATIVISTIC PLASMA IN VARIABLE FIELDS. S.T.Beliaev and G.I.Budker.
"Plasma physics", Vol. II (see Abstr. 5439 of 1961) p. 383-4

13077 PLASMA PHYSICS AND THE PROBLEM OF CONTROLLED THERMONUCLEAR REACTIONS. [FOUR VOLUMES]. VOLUMES II-III.
London: Pergamon Press (1959) 457 and 422 pp.

For abstracts of the articles from these volumes see Abstr. 7037-40, 7044-8, 7228, 7246, 7410, 9577-83, 13076 of 7027, 7035-6, 7043, 7049-67, 7419, 10708, 10767 of 1961.

13078 THE THEORY OF SYSTEMS OF RAREFIED PAR IN AN EXTERNAL FIELD.
I.R.Yukhnovs'kȳi, I.Sh.Rakhimova and V.V.Vladȳmirov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 334-44 (1959). In Uk

A system of ions in an external field is considered, the s range and Coulomb forces being taken into account. The free energy of the system is found. A method is developed for fu indeterminate differentiation, which leads to distribution fun

13079 INTERPENETRATION OF TWO IONIZED GAS C J.N.Tandon.
Indian J. Phys., Vol. 35, No. 4, 193-8 (Feb., 1961).

It is shown that the counter streaming will, in general, b unstable and the double stream will form small clouds of spa charge at the expense of streaming energy of the clouds. Th small clouds are responsible for the geomagnetic storms and the generation of radio noise from colliding galaxies.

13080 SCREW INSTABILITY OF A PLASMA COLUMN. F.C.Hoh and B.Lehnert.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 75-6 (Aug. 1, 1961).

Suggests that this instability, observed in a longitudinal field, is due to the separation of the ions and electrons into s screws. This gives rise to an azimuthal electric field which the particles outwards and destroys the stability. However th ambipolar electric field will tend to rotate the electron screw to oppose the charge separation; when the two effects balance screw pattern may become steady. J.W.S

13081 EXPERIMENTAL EVIDENCE FOR BEAM—PLAS INTERACTION IN A LOW-PRESSURE ARGON DI CHARGE. L.H.Putnam, H.D.Collins and N.L.Oleson.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 77-9 (Aug. 1, 1961).

A cylindrical Langmuir probe indicated two distinct grou electrons, corresponding to the beam and the plasma, which as the distance of the probe from the cathode was increased, ing interaction. The resultant density and velocity fluctuatio rise to plasma oscillations. J.W.S

82 THE INFLUENCE OF A MAGNETIC FIELD ON ION DIFFUSION IN A STATIONARY PLASMA IN HELIUM.

sil'eva and V.L.Granovskii.
tekhnika i Elektronika (USSR), Vol. 4, No. 12, 2051-60
1959). In Russian.

robe measurements were made on a helium plasma in the nce of a longitudinal magnetic field in the range 0-2600 Oe ler to determine how much the magnetic field reduces loss of e carriers from the plasma, to determine the character of er diffusion and to find the dependence of the diffusion co- ent on the magnetic field. The results show that with mag- fields, the limiting values of which depend on the gas pressure ibe current, the carrier loss to the walls decreases with ase in magnetic field and the diffusion coefficient decreases ncrease in field approximately according to Townsend's law. on diffusion is found to have an ambipolar character.

R.C.Glass

083 MAGNETOHYDRODYNAMIC EQUATIONS.

R.V.Polovin and N.L.Tsȳntsadze.
yin. fiz. Zh. (USSR), Vol. 4, No. 1, 30-8 (1959). In Ukrainian.

t is proved that these equations may be obtained from the ions of motion of electrons and ions in the limiting cases v frequencies: (1) when the free path is considerably less than haracteristic lengths (frequent collisions); and (2) when the free is considerably greater, and the ion Larmor radius is considerless than the characteristic lengths (rare collisions). It is n that, if collisions are rare, equations of state exist, provided the motion of the charged particles along the magnetic field is finite. The phase velocities of small amplitude fluctuations ound. It is proved that the plasma is unstable relative to l amplitude oscillations if the anisotropy of pressure is ciently large.

3084 COMMENT ON "PLASMA MOTION ACROSS MAGNETIC FIELDS". H.P.Furth.

. of Fluids (USA), Vol. 4, No. 6, 787-8 (June, 1961).

Discusses the flow of current required to accelerate plasma ss lines of force. The relative displacement of ions and trons must equal the gyro-radius of an ion at the final drift city. High drift velocities usually require flow of current in out of electrodes. In this sense the plasma is not a dielectric, n all bulk properties, the magnetized plasma exhibits familiar ectric-like properties.

R.S.Pease

3085 ANSWER TO THE COMMENTS BY H.P.FURTH.

G.Schmidt.
. of Fluids (USA), Vol. 4, No. 6, 788 (June, 1961).

The disagreement with Furth (see preceding abstract) is one of enclature.

R.S.Pease

3086 MAGNETOSONIC WAVES IN A RAREFIED PLASMA.

K.M.Stepanov.
ayin. fiz. Zh. (USSR), Vol. 4, No. 5, 678-9 (1959). In Ukrainian.

3087 MICROWAVE ATTENUATION BY CYCLOTRON RESONANCE IN A SLIGHTLY IONIZED GAS. T.Dodo.

hys. Soc. Japan, Vol. 16, No. 2, 293-301 (Feb., 1961).

The Boltzmann equation is solved for the distribution function of trons in a static uniform magnetic field B_0 and a high frequency tric field. The tensor of dielectric constant and the propagation stant k are obtained from this solution. The calculations are e by neglecting the square of the amplitude of electric field for cases: (1) $k // B_0$, (2) $k \perp B_0$. The attenuation spectrum for the e (2) is not a Lorentzian type and its maximum occurs at the rowave frequency

$$\omega \cong (\omega_c^2 + \omega_p^2 + \nu_m^2)^{1/2}.$$

e electron density is high, the attenuation spectrum differs n a Lorentzian type even for the case (1).

3088 ELECTROSTATIC POTENTIAL GRADIENTS IN A PENNING DISCHARGE.

lz, R.G.Meyerand, E.C.Lary and A.P.Walch.
. Rev. Letters (USA), Vol. 6, No. 10, 523-5 (May 15, 1961).

Discusses the circumstances in which electrostatic potential lients may exist in a plasma over distances long compared to Debye wavelengths. The necessary lack of thermal equilibrium be provided by continuous ionization of neutral gas in the plasma. s the theory for the case of a Penning discharge, and shows agreement with probe measurements of plasma potential.

R.S.Pease

DETONATION-GENERATED PLASMAS. See Abstr. 12915

13089 EXPERIMENTS ON THE CONFINEMENT OF AN ELECTRON GAS IN A MAGNETIC FIELD.

B.Bonnevier.
Ark. Fys. (Sweden), Vol. 18, Paper 30, 421-31 (1960).

The confinement of electrons in different types of magnetic "bottles" is studied experimentally. A cathode is placed inside the confinement region and the electron current to the surrounding walls is measured as a function of the magnetic field strength. Toroidal and mirror-shaped fields are examined as well as the field generated by a circular current loop. The experiments indicate that the field generated by the current loop can be used to trap particles in all directions. Further, it is found that the suppression of the total electron current is controlled only by the poloidal part of the magnetic field, as predicted by theory.

13090 STABILITY OF A PLASMA WITH A CONTINUOUS DENSITY DISTRIBUTION. B.Lehnert.

Phys. of Fluids (USA), Vol. 4, No. 8, 1053-4 (Aug., 1961).

Treats the stability of the magnetic confinement of a plasma in an infinite plane approximation, with a magnetic field in the Z direction, for disturbance wavelengths L_x and L_y smaller than the distance over which the density changes appreciably, but larger than the Larmor radii. Gives a stability criterion, and finds growth rates of unstable perturbations are much smaller than those obtained by Rosenbluth and Longmire (Abstr. 8727 of 1957).

R.S.Pease

13091 STABLE PLASMA CONFINEMENT BY MULTIPOLE FIELDS. T.Ohkawa and D.W.Kerst.

Phys. Rev. Letters (USA), Vol. 7, No. 2, 41-2 (July 15, 1961).

Describes an arrangement, which may be either linear or toroidal, consisting of currents flowing along a set of parallel rods placed regularly in cavities in a complete outside conducting wall which acts as a current return path. Stability conditions and containment times are quoted.

J.W.Sturgess

13092 MEASUREMENT OF PLASMA TEMPERATURE AND ELECTRON DENSITY. K.Murakawa and S.Hashimoto.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1824 (Dec., 1959).

In accordance with calculations by Griem, Kolb and Shen (Abstr. 1480 of 1960) concerning pressure broadening of spectral lines, the authors correct their previously published (Abstr. 313 of 1961) values of electron concentration and plasma temperature in a constricted discharge in neon at low pressures.

K.A.Thomas

13093 A METHOD FOR MEASURING HIGH ELECTRON DENSITIES IN PLASMAS. S.Takeda and M.Roux.

J. Phys. Soc. Japan, Vol. 16, No. 1, 95-8 (Jan., 1961).

It is proposed that high electron densities in plasmas can be determined from the complex reflection coefficient of a plane microwave at the plasma boundary. The coefficient which is related to the electron density and the collision frequency in plasmas is measured from the standing wave pattern produced by the incident and reflected wave at the boundary. As a result of the calculation, for a microwave frequency of 9000 MC, electron densities of 10^{14} and 10^{16} cm^{-3} are determinable respectively from the measurement of 11 and 1.1 degree in the phase angle of the complex reflection coefficient.

13094 CAVITY METHOD SUITABLE FOR MEASUREMENT OF HIGH ELECTRON DENSITIES IN PLASMAS.

J.M.Anderson.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 975-8 (Aug., 1961).

It is shown that a columnar geometry of electrical gaseous plasma may be examined by the conventional microwave cavity method, and results may be interpreted such that plasma electron densities considerably above that corresponding to "resonance" with the applied microwave frequency may be determined.

13095 ASYMMETRIC COLLAPSE ACCELERATORS FOR COUNTER-HELMHOLTZ GEOMETRIES WITH INTERNAL INJECTION. R.W.Waniek, H.Fischer and S.W.Lee.

Phys. of Fluids (USA), Vol. 4, No. 7, 928-9 (July, 1961).

Pulse currents ringing at about 250 kc/s are passed through two conically-shaped coaxial single-turn coils surrounding a shaped insulating chamber containing (typically) 100 mtorr of H_2. Observations with light and small search coils suggest that plasma is ejected at about 10^7 cm sec^{-1} from each cone, collides in the central field-free region of the cusp, and creates oscillations of about 20 Mc/s.

R.S.Pease

Plasma Oscillations

13096 RADIATION OF PLASMA OSCILLATION.
S.Kojima and S.Hagiwara.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1904 (Oct., 1960).

See Abstr. 19700 of 1960. Microwave emission and reflection from the plasma of a hot-cathode mercury-vapour discharge tube were observed as functions of the discharge current at fixed frequencies. A special tube 40 cm long by 2.8 cm diameter with two grids and a pair of probes, designed to eliminate low-frequency oscillations, was used. For a pressure of 3μ and at 9.6 kMc/s, an emission peak power of ~10 $\mu\mu$W occurred at a discharge current of 1A, when the plasma frequency became equal to the observation frequency; the reflection also saturated at this current. Radiation was especially intense from the inhomogeneous plasma regions near the cathode, first grid and the probes. D.M.Gilbey

LANDAU DAMPING IN A PLASMA. See Abstr. 13048

ELECTRON EMISSION
ELECTRON BEAMS

13097 THE WORK FUNCTION AND THE SURFACE PROPERTIES OF THE COPPER—BARIUM SYSTEM.
Yu.G.Shishkin and I.L.Sokol'skaya.
Fiz. tverdogo Tela (USSR), Sbornik [Supplement] II, 273-5 (1959). In Russian.

The work function of barium layers deposited on copper and heated for 20 min at 500°C was φ = 3.4 eV. The surface of the system had "islands" of pure barium with φ = 2.6 eV. A.Tybulewicz

13098 EFFECT OF TEMPERATURE ON THE EXOEMISSION OF ELECTRONS FROM ABRADED ALUMINUM SURFACES. W.T.Pimbley and E.E.Francis.
J. appl. Phys. (USA), Vol. 32, No. 9, 1729-33 (Sept., 1961).

A model and resulting theory for the exoemission of electrons from metal surfaces are presented. The model states that the exoemission is governed by the diffusion of vacancies in the metal, vacancies created by the abrasion. A vacancy, upon diffusing to the surface, may give up its energy to an electron. However, when in the same event, a photon also transfers its energy to the electron, the electron may be emitted. Experiments performed show the exoemission decay to be composed of two exponential decays. Both exponential decay constants vary with temperature according to the equation:

$$k = Fe^{-E/RT}.$$

Here, F is a constant and E is an activation energy which, measured, approximates 5.6 kcal/mole. A comparison between experiment and theory give the theory corroboration.

STUDY OF EXO-ELECTRON EMISSION FROM ALUMINIUM. See Abstr. 12590

13099 FIELD EMISSION FROM DIELECTRICS CONTAINING IMPURITIES. M.I.Elinson, G.F.Vasil'ev and A.G.Zhdan.
Radiotekhnika i Elektronika (USSR), Vol. 4, No. 10, 1718-31 (Oct., 1959). In Russian.

Gives the results of a detailed experimental investigation of the field emission of corundum (Al_2O_3) and fused quartz (SiO_2) containsome carbon as impurity. The preparation of the emitters is described. Measurements were made of current—voltage characteristics, work function and conductivity. The measured V—I characteristic is found to differ somewhat from the theoretical at high current densities. The effect of temperature on field emission was also investigated and a comparison is made between the thermionic emission and field emission properties. The materials were found to have a high work function for thermionic emission but a low work function for field emission, indicating that the conditions for field emission differ from those for thermionic emission. R.C.Glass

13100 ON THE ELECTRON EMISSION FROM OXIDE COATED CATHODE SUBJECT TO STRONG ELEC FIELD. C.Shibata.
J. Phys. Soc. Japan, Vol. 16, No. 1, 51-61 (Jan., 1961).

The emission was measured in a wide range of electric fi intensity, where a deviation from Shottky effect appears. The phenomena could be explained by considering the emission inc by an avalanche effect in the oxide layer. The calculation of t enhanced emmission current was performed and compared wi measured results.

13101 COLD-EMITTING CATHODE MATERIALS.
Y.Mizushima, Y.Igarashi and T.Imai.
J. Phys. Soc. Japan, Vol. 15, No. 4, 729 (April, 1960).

Oxides of 39 metals were tested for the possibility of cold electron emission in the manner exhibited by MgO. In general metals whose oxides show the effect lie in groups II, III or IV periodic table. A number of silicates and tungstates also show effect. No sample was as powerful an emitter as MgO. C.H.

13102 THERMIONIC EMISSION OF UC—Nb.
R.H.Abrams and F.E.Jamerson.
J. appl. Phys. (USA), Vol. 32, No. 9, 1783-4 (Sept., 1961).

The thermionic constants of a uranium carbide—niobium (80% -20% by volume) cathode were determined from emission measurements in the temperature range 1380°-1960° K, using t Richardson plot method. The Richardson constants were found be ϕ=3.27 eV and A = 90 amp cm^{-2} °K^{-2}, with a temperature coefficient of work function of 2.5 × 10^{-5} eV °K^{-1}. C.H.

13103 THERMIONIC [ELECTRON] EMISSION PROPERT OF METAL-LIKE COMPOUNDS.
H.V.Samsonov, V.S.Neshpor and Yu.B.Paderno.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 508-18 (1959). In Ukr

An explanation is given of the electric properties and the function of the transition elements and their compounds with boron, carbon, silicon and nitrogen. Methods are described f obtaining hexaborides of rare-earth metals, their pseudobinar alloys and sintered samples of these materials.

13104 ELECTRON MICROSCOPE STUDY OF THE DECO POSITION PROCESS OF OXIDE COATED CATHO
S.Hirota and T.Imai.
J. Phys. Soc. Japan, Vol. 15, No. 1, 137-44 (Jan., 1960).

Electron microscope observations on oxide coated cathod undertaken especially in relation to the decomposition process the effect of prolonged heat treatments. A new replica metho in this study was as follows: (1) deposition of a SiO film on a specimen, (2) pressing the SiO-coated specimen onto ethyl me crylate resin film, (3) shadowing by germanium evaporation a (4) reinforcing with a carbon film. This replica technique ma it possible to observe the exact surface structure of an oxide which has a porous surface and which is very unstable in the sphere. The following results were obtained on the decompos process: Growth of the oxide crystal becomes significant at a certain decomposition temperature. For "triple carbonate", critical temperature lies around 1100° C; with "single carbona crystal growth occurs at considerably lower temperatures.

13105 EFFECT OF ELECTRON BOMBARDMENT ON GA GENERATION AND ON THE THERMIONIC EMISS OF AN OXIDE CATHODE. H.Ya.Pikus.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 329-42 (1958). In Uk

13106 PHOTOELECTRIC EMISSION IN THE TUNGSTEN BARIUM OXIDE AND TUNGSTEN—BARIUM SYST
A.R.Shul'man, M.L.Kapitsa, R.L.Nemchenok and E.V.Zelenets
Fiz. tverdogo Tela, (USSR), Vol. 2, No. 11, 2805-12 (Nov., 19
In Russian.

The work function of the W—BaO and W—Ba systems was studied, and spectral characteristics of the quantum efficienc determined for photocathodes with coatings, varying in thickn between zero and approximately 10 monolayers of adsorbed B BaO. The spectral characteristics of the photoeffect of the W specimens were essentially monotonic in character, with the exception of cathodes with less than one monolayer of the ads particles, in which case certain anomalies were observed. T anomalies were not present in spectral characteristics of cat with BaO coatings of similar thickness, and it was inferred th decisive part in photoemission is (in this case) played by the photoelectrons of the metal with lower work function. In the cathodes with thicker BaO coatings, anomalies were observed

ım efficiency curves. These could not be associated with the rties of the W substrates, and were attributed to the presence). [English translation in: Soviet Physics—Solid State (USA)].
M.H.Sloboda

107 PROPERTIES OF PHOTOEMISSION FROM INDIUM ARSENIDE.

ırsen'eva-Geil' and Van Bao-Kun' [Wang Pao-K'un].
verdogo Tela (USSR), Vol. 3, No. 5, 1622-3 (May, 1961).
ssian.

hotons of various energies were directed against n-type samples and the volt—ampere characteristics were plotted. cases the maximum energy of the emitted photoelectrons was ıme. This indicates that the photoelectric work function s directly as the energy of the incident photons.
A.E.I. Research Laboratory

108 MEASUREMENT OF WEAK PHOTOCURRENTS IN STUDIES OF PHOTOELECTRIC EMISSION.

Tyutikov and Yu.A.Shuba.
a i Spektrosk. (USSR), Vol. 9, No. 5, 631-4 (Nov., 1960).
ssian.

)escribes a method of measuring weak photocurrents (down to ral photoelectrons per second) based on the use of an electron plier with a demountable photocathode. The photoemission es of platinum, beryllium bronze, strontium fluoride and r treated with iodine were obtained by this method in the length region 1216-5461 A. The quantum yields varied from to 10^{-14} electrons/quantum between hν of 10 and 3 eV. sh translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, (Nov., 1960)].
A.Tybulewicz

109 MEASUREMENT OF THE PHOTOELECTRIC EMISSION YIELD OF 1.54-13.3 A X-RAYS.

ukirskii, M.A.Rumsh and I.A.Karpovich.
a i Spektrosk. (USSR), Vol. 9, No. 5, 653-7 (Nov., 1960).
ssian.

)escribes the use of an Allen-type multiplier in measurements toelectric emission produced by X-rays of 1.54-13.3 A wave-ns. The photoelectric yields were found for Ti, W, Pt, NaBr, nd SrF_2. [English translation in: Optics and Spectrosc. (USA), , No. 5, 343-6 (Nov., 1960)].
A.Tybulewicz

110 INCREASING THE SENSITIVITY OF Cs_3Sb PHOTOCATHODES BY OPTICAL METHODS.

3orzyak.
yin. fiz. Zh. (USSR), Vol. 3, No. 3, 324-8 (1958). In Ukrainian.

111 EFFECT OF AN ADSORBED BaO FILM ON THE PHOTOELECTRIC PROPERTIES OF Cs_3Bi PHOTO-IODES. O.H.Sarbei.

yin. fiz. Zh. (USSR), Vol. 3, No. 3, 358-64 (1958). In Ukrainian.

Measurements of the optical transparency of a Cs_3Bi photo-de give $\Delta E_{opt} \cong 0.5$-0.7 eV. The photoelectric work function mined from the data of Apker et al. (Abstr. 4778 of 1949) is $\cong 1.64$ eV. This gives a value of $\chi \cong 1.1$-0.9 eV for the external tial barrier, within which limits a decrease in the work ion is possible. The values obtained for the thermionic and electric work functions for one of the photocathodes equal, ectively, $\varphi_{ph} \cong 1.6$ eV and $\varphi_{ph} = 1.7$ eV. Thus the chemical tial level in the Cs_3Bi photocathodes is near the top of the cy band. The change in the thermionic work function mined by the method of volt—ampere curve shifts, which esponds to the optimal barium oxide coating of the cathode, ed equal to $\Delta\varphi \cong 0.2$ eV. The changes in spectral sensitivity ring at optimal coating of the cathodes with BaO molecules vident on comparing the various data. The low values of $\Delta\varphi$ be explained by the dependence $\Delta\varphi = f(\chi)$. Another possible nation involves the assumption that the initial cathode work func-s defined by the presence of an active adsorbed alkali metal film in athode surface. There remains, therefore, little possibility e further reduction of the work function.

112 SPECIAL FEATURES OF THE TEMPERATURE DEPENDENCE OF PHOTOEMISSION OF MULTI-LI CATHODES. G.Frischmuth-Hoffmann, P.Görlich and

ra.
turforsch. (Germany), Vol. 15a, No. 11, 1014-16 (Nov., 1960).
rman.

3riefly indicates some unusual behaviour of the quantum yield a multi-alkali cathode ($Cs\,Na_x\,K_{3-x}\,Sb$) at temperatures of about 90°K compared with the yield at room temperature and with that from a Cs_3Sb-cathode.
A.E.I. Research Laboratory

13113 SOME PRELIMINARY EXPERIMENTS CONCERNING THE INFLUENCE OF BAND BENDING ON PHOTO-ELECTRIC EMISSION. J.J.Scheer.

Philips Res. Rep. (Netherlands), Vol. 15, No. 6, 584-6 (Dec., 1960).

The theory that p-type semiconductors should exhibit a higher photoelectric quantum efficiency than n-type semiconductors is verified by measurements of the photo emission from caesium-covered silicon surfaces.

13114 DEPTH OF PHOTOELECTRON ESCAPE FROM Ge. O.H.Sarbei.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 399-400 (1959). In Ukrainian.

13115 PHOTOELECTRIC EMISSION OF Ge AND Si IN THE AMORPHOUS AND CRYSTALLINE STATES.

P.H.Borzyak, L.S.Myroshnychenko and O.H.Sarbei.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 524-5 (1959). In Ukrainian.

13116 VOLT—AMPERE CHARACTERISTICS OF THE PHOTOELECTRIC EMISSION OF Ge.

P.H.Borzyak, P.M.Marchuk and O.H.Sarbei.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 525-6 (1959). In Ukrainian.

13117 MODIFICATION OF A PHOTOMULTIPLIER FOR USE IN THE FAR ULTRAVIOLET. R.W.Patch.

Rev. sci. Instrum. (USA), Vol. 32, No. 8, 983 (Aug., 1961).

A modification to a photomultiplier tube is described which solves the stray light problem. The modification involves opening the tube and depositing KCl on to the suitably masked photocathode by vacuum evaporation. At 1150 A the signal : noise ratio is increased by a factor of 24 over that of a commercial tube coated with sodium salicylate. The quantum efficiency of a KCl coated brass photocathode was found to be 13% compared to the 9% obtained with an indium coated photocathode.
D.Llanwyn-Jones

13118 OPERATION OF CESIUM—ANTIMONY PHOTOTUBES UNDER HIGH LIGHT LEVEL. K.Miyake.

Rev. sci. Instrum. (USA), Vol. 32, No. 8, 929-33 (Aug., 1961).

The fatigue phenomena of vacuum and gas-filled Cs—Sb photocathodes were studied. It is shown that the phototubes can be operated without fatigue at high photocurrent densities, about 90 μA cm^{-2}, by reducing the temperature rise of the cathode due to high illumination and by lowering the anode voltage to be applied. The photocathodes whose responses ranged from 30 to 60 μA/lu were used to study the changes of their sensitivities in the following experiments: (a) effect of intense illumination on the sensitivity; (b) variation in the response by heating at elevated temperatures, and (c) relation between the change in photoresponse and the positive potential applied to the anode. The results obtained were as follows: in red radiation the thermal effects dominated, and in blue—green radiation an effect on the photosensitivity due to the absorption in the caesium antimonide film appears. The photoresponse was appreciably reduced when a positive potential above the ionization potential of the gas in the phototubes was applied to the anode. At a very high light level the fatigue phenomena of the cathodes may be caused mainly by the thermal decomposition of caesium antimonides.

13119 QUANTUM YIELD OF GOLD-CATHODE PHOTO-MULTIPLIERS. C.B.Childs.

J. Opt. Soc. Amer., Vol. 51, No. 5, 583 (May, 1961).

Experiments on two EMI type 6255 G tubes lead to the expectation that the optimum thickness of the gold cathode layer can be determined during evaporation using a high flux at 2537 A for monitoring.
A.H.W.Beck

13120 THE ENERGY SPECTRA OF SECONDARY ELECTRONS IN VARIOUS MATERIALS IRRADIATED BY GAMMA RAYS FROM ^{60}Co AND ^{137}Cs. N.Oda and H.Syzuki.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2365-6 (Dec., 1960).

Measurements were made with a scintillation spectrometer and using target materials of polyethylene, Al, Cu and Pb. Energy spectra data are given over the energy range 0-1.4 MeV for Co^{60} and 0-0.7 MeV for Cs^{137}.
J.W.Taylor'

13121 PRODUCTION OF δ-ELECTRONS IN DISTANT COLLISIONS BY CHARGED ULTRARELATIVISTIC PARTICLES. V.Bortolani.

Nuovo Cimento (Italy), Vol. 20, No. 5, 977-82 (June 1, 1961).

A method is discussed to determine the connection between the number of δ-electrons, extracted by distant collision of an ultra-relativistic particle with the electrons of a medium, and the $\gamma = 1/\sqrt{1-(v/c)^2}$ of the particle. The Weizsäcker—Williams method is used to reduce the problem to a photoelectric effect. Hydrogen atom type eigenfunctions are used to describe the metallic electrons. Errors due to this approximation are estimated.

13122 INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF SECONDARY ELECTRON EMISSION FROM PIEZO-ELECTRIC MONO-CRYSTALS.

E.S.Mashkova and G.A.Chetverikova.
Radiotekhnika i Elektronika (USSR), Vol. 4, No. 12, 2068-71 (Dec., 1959). In Russian.

The secondary emission properties of barium and lead titanate mono-crystals were studied. Curves of the secondary emission coefficient as a function of primary electron energy at temperatures in the region of the Curie point were obtained as well as curves of the secondary emission coefficient as a function of temperature for various primary electron energies. The curves show a minimum in the region of the Curie point for all values of primary electron energy. R.C.Glass

13123 A STUDY OF THE KINETICS OF MOTION OF ELECTRONS IN SECONDARY EMISSION. I.

M.H.Nakhodkin and V.O.Romanovs'kӯi.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 479-90 (1959). In Ukrainian.

The method of isolated pulses was employed to investigate the thickness dependences of the secondary electron emission of wedge-shaped layers of KCl on a gold or beryllium substrate, beryllium and germanium on a glass substrate, antimony on an aluminium substrate. It was shown that on the curve of the secondary emission versus thickness there are two characteristic thicknesses d_1 and d_2, for which the rate of change of emission δ with the thickness of the layer is retarded. Depending on the pair of substances of the emitter and the substrate, the course of the thickness curve of secondary emission may vary qualitatively in the range of thicknesses $d_1 < d < d_2$. The change in δ with thicknesses exceeding d_1 is connected with the back scattering of primary electrons.

13124 SPACE-CHARGE LIMITED CURRENT RELATION IN HIGH-PRESSURE GAS DIODES. R.Forman.

Phys. Rev. (USA), Vol. 123, No. 5, 1537-41 (Sept. 1, 1961).

A theory for space-charge conditions in high-pressure diodes is developed which shows that the current obeys a $V^{3/2}$ power relation rather than the usually assumed V^2 relation. In addition, the theory predicts that the current in high-pressure diodes, at a constant anode voltage, varies as $p^{-1/2}$. Experimental data, taken in diodes filled with the inert gases, argon, neon, and helium, are presented to illustrate the validity of the theory.

13125 VARIOUS SCALAR POTENTIALS, MAGNETIC AND ELECTRIC FIELDS AND MAGNETIC INDUCTION IN THE PLANE OF SYMMETRY OF A SLAB OF CONSTANT THICKNESS. M.Cotte.

C.R. Acad. Sci. (France), Vol. 252, No. 19, 2842-4 (May 8, 1961). In French.

The polar faces of a slab have the same projection on the plane of symmetry (a closed contour curve). The field expressions are derived; these are useful for the study of aberrations of electron trajectories in an appropriate lens model. J.K.Skwirzynski

13126 ELIMINATING THE EFFECT OF THE DELETERIOUS MAGNETIC FIELD COMPONENT IN A MAGNETIC UNDULATOR.

I.O.Hrӯshayev, V.I.Kolosov, V.I.M'yakota and B.V.Yakӯmov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 6, 810-12 (1959). In Ukrainian.

13127 INELASTIC SCATTERING OF ELECTRONS AND SECONDARY ELECTRON EMISSION OF CERTAIN METALS. III. I.M.Bronshtein and R.B.Segal'.

Fiz. tverdogo Tela (USSR), Sbornik [Supplement] II, 258-63 (1959). In Russian.

For Pt II see Abstr. 7147 of 1960. Reports the dependence of the secondary emission and the inelastic scattering coefficients of platinum on the primary electron energies up to 3600 eV. Deals with the range-energy relationships for primary and slow secondary electrons. Ends with a summary of conclusions reached in Pts I-III. A.Tybulewicz

13128 ROLE OF Ba IN THE INCANDESCENCE OF MET
OXIDE PARTICLES DUE TO ELECTRON BOMBA
MENT. H.S.Mӯkhailov.

Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 812-13 (1959). In Ukra

ION EMISSION . ION BEAMS

13129 SECONDARY ION (ION-ION) EMISSION FROM SI
CRYSTALS OF SODIUM CHLORIDE UNDER BOM
MENT BY LITHIUM IONS. G.M.Batanov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 642-50 (Feb., 1961)
In Russian.

The experimental investigation was carried out using the
described in Abstr. 11965 of 1961. It was found that the seco
positive ion coeff. K, and its dependence on the primary ions
energy $K(E_0)$, is of the order of that for metals, and that it is
independent of temperature in the range 100° - 300°C. It was
that for incident ions of energy < 500 eV, the secondary ions
those of lithium with energies up to 50 eV. For incident ions
energy > 500 eV it is supposed that the secondary ions are th
of sodium produced by the disintegration of the target surface
changes in the surface, caused by the adsorption of gases and
bombardment, affect $K(E_0)$ for $E < 300$ eV. [English translati
in: Soviet Physics — Solid State (USA), Vol. 3, No. 2, 471-6
(Aug., 1961)]. J.M.Za

13130 CRITICAL EFFECT OF THE GEOMETRY OF AN
EXTRACTION SYSTEM OF A HIGH-FREQUENCY
PROTON SOURCE ON THE CURRENT INTENSITY OF THE I
BEAM. M.D.Habovӯch and H.N.P'yankov.

Ukrayin fiz. Zh. (USSR), Vol. 3, No. 3, 419-20 (1958). In Ukra

13131 MOTION OF A CHARGED PARTICLE IN A STAT
MAGNETIC FIELD WITH AXIAL SYMMETRY.

H.Obayashi.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 297-9 (Feb., 196

The motion of a charged particle in an axially symmetric
magnetic field is considered. In order to discriminate betwe
characteristic parts of the motion of the particle a canonical
formation is introduced. The motion of the particle is invest
only in the neighbourhood of the axis of symmetry, and the or
obtained. W.E.W

13132 A TWO-DIRECTIONAL FOCUSSING HIGH-INTEN
MASS-SPECTROMETER. S.B.Karmohapatro.

Indian J. Phys., Vol. 34, No. 9, 407-15 (Sept., 1960).

A mass-spectrometer of focussing angle $\sqrt{2}\pi$ with mean
381 mm, variable 20 kV accelerating voltage, is described. Fo
properties and performance with a magnetic oscillation-type
source for gases are studied, indicating that the instrument m
useful for studies of collision of ions in gases and solids, for
preparation of isotopic targets and β-sources by direct depos
method.

13133 MASS DEPENDENT ION COLLECTION EFFICIEN
IN A MASS SPECTROMETER.

D.A.Kubose and W.H.Hamill.
J. phys. Chem. (USA), Vol. 65, No. 1, 183-4 (Jan., 1961).

The ratio of the analysed ion current (at a given m/e) to
total saturation current measured on negatively biased repell
electrodes was investigated for a number of gases as a functi
repeller field. In the m/e region investigated there is little d
crimination (in the instrument used) except at low m/e.
M.R.C.Mc

13134 A MASS SPECTROMETER WITH QUADRUPOLE LENSES EXCITED AT HIGH FREQUENCY.

M.Gaudaire.
J. Phys. Radium (France), Vol. 21, Suppl. No. 3, 70A-72A (March, 1960). In French.

A mass spectrometer of the type developed by Paul (Abst
8059 of 1958) is described. In order to observe masses up to
A = 20, a 150 W signal of about 5 kV at 5 Mc/s is applied to th
cylindrical bars of the quadrupole lenses. The ion source is
sphere of lithium aluminium silicate producing a 1μA current
lithium ions through a 2 mm diaphragm. Spectra of lithium a
discharges in air and ammonia are shown. F

MAGNETIC-RESONANCE MASS SPECTROMETER.
str. 12682

135 REDUCTION OF POTASSIUM ION BACKGROUND IN TUNGSTEN SURFACE IONIZATION DETECTORS FOR
CULAR BEAMS. E.F.Greene.
sci. Instrum. (USA), Vol. 32, No. 7, 860-1 (July, 1961).
eposition of tungsten from $W(CO)_6$ on to a tungsten ribbon
ces a surface ionization detector in which no interference from
sium ions occurs. G.I.W.Llewelyn

136 CATHODE SPUTTERING BY RARE-GAS IONS OF LOW ENERGY. M.Koedam.
s Res. Rep. (Netherlands), Vol. 16, No. 2, 101-44 (April, 1961).
xperiments were carried out using mono-energetic rare-gas
striking the surface perpendicularly. The ion energy varied
en 50 and 1500 eV. The apparatus used, as well as a few
urements directed towards determining the average energy
nergy spread of the bombarding ions are described. The
tion of atoms freed by ion bombardment is discussed. The
ing new method is described: the quantity of sputtered metal,
ted on a glass plate, is determined from the optical trans-
on of glass plate and metal layer. The author compares the
ture of silver (and copper) layers formed by evaporation and
uttering respectively. For polycrystalline silver, the relation-
etween the sputtering yield (atoms/ion) and the energy of the
-gas ions (40-250 eV) was determined. For bombardment of
crystalline copper by the above ions at energies up to 1500 eV,
gular distribution of the sputtered material was measured.
appears to be a preferential ejection of atoms in the $< 110 >$
100 > lattice directions. The distribution of sputtering
sity among different preferential ejection directions depends
ion species and energy. Some qualitative observations are
regarding the phenomena occurring in an ion-bombarded metal
e. The appearance of preferential ejection directions and of
ationship between angular distribution and the energy of the
ling ions are explained.

PARTICLE ACCELERATORS

3137 FIELDS IN CAVITY-EXCITED ACCELERATORS. E.G.Cristal and J. Van Bladel.
pl. Phys. (USA), Vol. 32, No. 9, 1715-24 (Sept., 1961).
ield configuration and resonant frequency are determined for
west azimuthally-independent mode of a coaxial cavity
unding a circular tube. Several values of the width of the
ing gap are considered, and the central problem consists in
mining the tangential electric field E_t in that gap. It was found
he fields near the axis of the accelerator are quite insensitive
actual profile of E_t, and that satisfactory results are obtained
suming E_t to be constant. The problem is repeated for a
llel plane configuration, with the purpose of investigating the
ence of the flattening of the cavity. Computations show that the
onfigurations yield fairly similar results.

3138 ACCELERATOR ENERGY CALIBRATIONS. J.B.Marion.
mod. Phys. (USA), Vol. 33, No. 2, 139-47 (April, 1961).
Energy calibration points are calculated from the weighted
s of published results for five primary energies in the range
to 1.88 MeV, which have been determined by absolute analysers.
secondary points are determined from relative and absolute
surements (0.44 to 3.24 MeV) and twelve other useful values are
ed from the latest published figures (1.02 to 4.89 MeV). Methods
recommended for the measurement of gamma ray resonances
eutron thresholds and the importance of target conditions is
asized. The calibration of an analyser using a spectrometer
scussed. J.W.Sturgess

3139 MODULATION OF HEAVY-PARTICLE LINEAR ACCELERATORS BY MEANS OF SLOW ELECTRONS.
.Fainberg and O.M.Nekrashevÿch.
yin.fiz. Zh. (USSR), Vol. 4, No. 6, 803-4 (1959). In Ukrainian.

3140 BEAM STABILITY IN STACKED ORBITS. A.A.Kolomenskii and A.N.Lebedev.
naya Energiya (USSR), Vol. 7, 549 (1959). In Russian. English
slation in: Plasma Phys. —Accelerators — Thermonuclear
(GB). Vol. 3, No. 1, 44-5 (Jan., 1961).
Plasma effects in stacking systems are considered. It is pointed out that under certain conditions they are absent azimuthally-restricted bunches in an accelerator. M.Hasan

13141 A RING CYCLOTRON WITH A VERTICALLY INCREASING MAGNETIC FIELD.
A.P.Fateev and B.N.Yablokov.
Atomnaya Energiya (USSR), Vol. 8, 552 (1960). In Russian. English translation in: Plasma Phys. —Accelerators — Thermonuclear Res. (GB), Vol. 3, No. 1, 45-6 (Jan., 1961).

An accelerator with a vertically increasing guiding magnetic field constant in time (a ring or FFAG cyclotron) is discussed. The construction of the accelerator and the stability of the motion of particles therein are investigated. M.Hasan

13142 SOME PROPERTIES OF ORBITS IN ACCELERATORS IN CONDITIONS OF SIMILARITY.
A.A.Kolomenskii and A.N.Lebedev.
Atomnaya Energiya (USSR), Vol. 8, 553 (1960). In Russian. English translation in: Plasma Phys. —Accelerators — Thermonuclear Res. (GB), Vol. 3, No. 1, 46-7 (Jan., 1961).

Some general properties of the motion of particles in accelerators, under conditions of dynamical similarity, are considered. The condition of similarity affects not only the geometry of the orbits but also the dynamics of the particles. Under this condition, it is impossible to set up a damping system based on a coupling between radial oscillations and synchrotron oscillations. The only possible method of overcoming radial instability is to set up an artificial coupling with the vertical oscillations. M.Hasan

13143 ON THE MECHANISM OF THE DAMPING OF FREE OSCILLATIONS IN A CYCLIC ACCELERATOR.
Yu.F.Orlov.
Zh. eksper. teor. Fiz (USSR), Vol. 35, No. 2(8), 525-7 (Aug., 1958). In Russian.

It is shown from energy considerations that both normal adiabatic damping and damping connected with the emission of radiation occur when the beam passes through an accelerating gap. [English translation in: Soviet Physics—JETP (USA), Vol. 35 (8) No. 2, 362-4 (Feb., 1959)]. T.O.Jeffries

X-RAY TUBES AND TECHNIQUES

13144 RADIOLOGY WITH HIGH-ENERGY X-RAYS. R.Halmshaw and C.G.Pollitt.
Progress in non-destructive testing, Vol. 2 (see Abstr. 9239 of 1961) p. 1-26.

Reviews the use of X-rays of energies greater than 1 MeV for industrial radiology. The factors determining the choice of peak energy, beamwidth and output are considered, and radiographic techniques, definition, sensitivity and exposure-times are discussed. Apart from general applications, special applications using stereo, flash, stroboscopic and neutron radiography are described. The characteristics of commercial X-ray machines are listed. 87 references. J.B.Birks

13145 DIE FORMING DOUBLY FOCUSING X-RAY MONOCHROMATORS. H.J.Garrett and H.A.Lipsitt.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 942-5 (Aug., 1961).

Reliable forming techniques for the preparation of doubly curved LiF X-ray monochromators are described. These techniques are applicable to the formation of doubly focusing one-piece monochromating crystals with geometries suited to a wide range of experimental requirements. The resulting dislocation structures were analysed and utilized in the development of the techniques and are presented as a guide for the preparation of similar focusing crystals.

13146 MODIFICATION OF A COSSLETT—NIXON MICROFOCUS X-RAY TUBE FOR USE AS AN X-RAY MICROANALYZER. R.R.Dils, L.Zeitz, D.L.Keith and R.A.Huggins.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1040-4 (Sept., 1961).

The tube was modified for use as an electron probe microanalysis unit, producing an electron beam of adequate intensity approximately one micron in diameter. The design of the unit is discussed, and a description of the electron optical design and the associated electronic power supplies is included.

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

13147 MEASUREMENTS OF A MAGNETIC FIELD.
C.Zucker.
Amer. J. Phys., Vol. 29, No. 9, 577-8 (Sept., 1961).

A method for measuring the average value of the magnetic field between pole pieces of a fixed magnet using a current-carrying wire was developed. This method vividly demonstrates the interplay of electromagnetic and mechanical forces and allows for the measurement of the average magnetic field.

13148 MEASUREMENT OF WEAK MAGNETIC FIELDS BY OPTICAL PUMPING METHODS. P.L.Bender.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 621-8 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A review and comparison of the d.c. alkali vapour magnetometer (Abstr. 6470 of 1957), the self-oscillating alkali vapour magnetometer (Abstr. 7317 of 1957; 6349 of 1958), and the helium magnetometer (Abstr. 722 of 1959; 13415 of 1960). Effects of orientation of the field are considered, and recent modifications made for specific applications are mentioned. For absolute measurements of slowly changing fields, the d.c. alkali vapour magnetometer is preferred. When orientation is not maintained, and fast response is desired, modifications of the self-oscillator are superior.

J.Sheridan

13149 A METHOD OF MEASURING WEAK FIELDS BY FREE PRECESSION IN CONJUNCTION WITH ELECTRONIC PUMPING. M.Bonnet and M.Servoz-Gavin.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 629-33 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A new method is proposed in which the increase in magnetization necessary for observation of free precession is obtained continuously by means of nuclear polarization. This overcomes restrictions on rate of repetition of measurement set by relaxation times in the technique of Packard and Varian [Phys. Rev. (USA) Vol. 93, 941 (1954)]. The sample is about 100 cm^3 of a solution of the substance $K_2NO(SO_3)_2$ subjected to sufficient power at 56 Mc/s to saturate the free electron spins. Brief details of the apparatus and results are given.

J.Sheridan

13150 FLEXURE MOUNTED BEAM BALANCE FOR LONG-TERM MAGNETIC STABILITY MEASUREMENTS.
D.E.Wilcox, W.M.Scarborough and W.L.Zingery.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1051-3 (Sept., 1961).

The balance measures an air-gap magnetic field change with a precision of one part in 30 000. The balance is supported on crossed flexures and operates on the torque-balance servo principle. A fixed torque is applied to the balance arm. Servo action causes the permanent magnet assembly to rotate in such a way as to create an opposition torque which is equal to that applied. The magnet speed required to establish torque balance depends on the square of the magnetic field. This speed is measured with great precision by a preset counter. A large number of magnet assemblies are measured.

13151 DESIGN AND CONSTRUCTION OF AN UNSYMMETRICALLY SCREENED FOCUSING PERMANENT MAGNET FOR TRAVELLING WAVE TUBES. M.Müller.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 247-55. In German.

The dimensions of an axially hollow focusing magnet, with a rectangular cross-section required to produce a field with a symmetry of 1 in 1000 or better, are derived. The calculations are done by replacing the magnetic system by a circuit with three elements having appropriate magnetic conductances in parallel. Homogeneity of the field in the cross-section of the travelling wave tube is achieved by means of magnetically soft guard rings not in contact with the magnet, the design in this respect deviating from the conventional practice. The screening of the magnet is unsymmetrical (unilateral). A graphic method for deriving the precise dimensions of the magnet and the screen plate is presented.

D.S.Parasnis

13152 TECHNIQUE OF SHUNTING PULSED, HIGH FIEL
MAGNETIC COILS. H.G.Hughes.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 964 (Aug., 1961).

A simple technique is described for shunting pulsed, high
magnetic coils after the field has reached the maximum value

ELECTROMAGNETISM
MAGNETOHYDRODYNAMICS

13153 A NOTE ON MULTIPOLE RADIATION.
H.B.G.Casimir.
Helv. phys. Acta (Switzerland), Vol. 33, No. 8, 849-54 (1960).

Using group theory, it is shown that the expansion in a se
of electric and magnetic fields leads to Debye potentials. Thi
agrees with a previous result (Abstr. 11229 of 1954) obtained
more elementary means. W.A.

13154 ELECTROMAGNETIC PARAMETERS OF MATTE
AND CONDITIONS FOR PHYSICAL REALIZABILI
G.Gerosa, G.Latmiral and R.Vinciguerra.
Nuovo Cimento (Italy), Vol. 20, No. 4, 610-16 (May 16, 1961).

(1) The conditions are examined which a complex function
real variable must satisfy in order that it may be considered
frequency response of a linear system. The cases of the phys
realizability and of the stability of the system are considered
use is made of the Hilbert transforms. (2) The relations exis
between the real and the imaginary part of the e.m. parameter
matter are studied by means of the Hilbert transforms, also k
as Kramers—Krőnig equations. The case of imperfect dielect
is particularly examined and a suitably modified form of Kra
Krőnig equations is presented. (3) The above considerations a
extended to the anisotropic media; special reference is made
the susceptibility of magnetized ferrites. When losses are pr
the parameters of the tensor are consequently finite for any
frequency, and must comply with the Kramers—Krőnig equatio
This is actually the case for the expressions which are genera
used.

13155 CORRELATION THEORY OF STATIONARY ELEC
MAGNETIC FIELDS. III. THE PRESENCE OF
RANDOM SOURCES. P.Roman.
Nuovo Cimento (Italy), Vol. 20, No. 4, 759-72 (May 16, 1961).

For Pt II, see Abstr. 19881 of 1960. The previously deve
correlation theory of stationary random electromagnetic field
extended to the case in which the fields interact with stationar
random charges and currents. The basic field equations are
and are found to be second order partial differential equations
analogue to the equation of continuity is derived and some illu
tive examples are discussed. Wave equations, which are of t
fourth order, are deduced for the electric and magnetic corre
tensors. The theory presented in this paper may have variou
applications for the theory of plasmas.

VARIOUS SCALAR POTENTIALS, MAGNETIC AND
ELECTRIC FIELDS AND MAGNETIC INDUCTION IN THE PL
OF SYMMETRY OF A SLAB OF CONSTANT THICKNESS.
See Abstr. 13125

13156 AXIOMATIC DEVELOPMENT OF THE LAWS OF
VACUUM ELECTRODYNAMICS. R.H.Lehmberg.
Amer. J. Phys., Vol. 29, No. 9, 584-92 (Sept., 1961).

The laws of classical vacuum electrodynamics are derive
three postulates relating to interactions among charges. Two
these describe the behaviour of a moving test charge in an ele
static field. Application of relativistic arguments to these tw
the Lorentz force law and Maxwell's equations for unaccelera
charges. The third postulate states that these laws are unalte
if the source charges are accelerated. The experimental bas
this postulate is discussed, and is found to be generally incon

13157 ELECTRIC DIPOLE APPROXIMATION AND THE
CANONICAL FORMALISM IN ELECTRODYNAMIC
M.Schwartz.
Phys. Rev. (USA), Vol. 123, No. 5, 1903-8 (Sept. 1, 1961).

The electric dipole approximation is used to study the pr
of finding commuting solutions of coupled equations of motion
a charged particle in an external radiation field, the solutions

ıupled equations cannot be considered independent in the sense
nmuting with one another if the homogeneous solutions are
ıed to have the commutation properties of uncoupled variables.
ase of a charged free particle and a charged harmonic oscilla-
an external radiation field are treated explicitly. It is
ıted that for a retarded (advanced) self-field, the free particle
ıto a canonical formalism while the oscillator does not. For
ionary self-field, both the free particle and the oscillator fit
canonical formalism. It is shown that the Fourier transforms
configuration space solutions (based on $e^{ik.x}$ and $e^{i\omega t}$) do not
In the latter connection, it is pointed out that earlier treat-
; of the oscillator by Sokolov and Tumanov (Abstr. 7123 of 1956)
orton and Watson (Abstr. 3913 of 1960) contain misleading
ts as a consequence of their using Fourier transforms.

3158 VARIATION OF THE HOMOPOLAR MOTOR.

T.D.Strickler.

:. J. Phys., Vol. 29, No. 9, 635 (Sept., 1961).

Describes the construction of and deals briefly with the theory
: homopolar motor.

3159 CHARGE AND CURRENT DENSITIES IN THE FARADAY DISC.

R.Ingraham.

o Cimento (Italy), Vol. 20, No. 3, 570-86 (May 1, 1961).

The current distribution in a Faraday disc (homopolar
rator) is investigated by solving approximately the magneto-
odynamical equations. The current density streamlines turn
o be spirals, with the possibility of a change in sense in the
that the magnetic field and the rotation axis are parallel. A
ing feature is the absence of solutions showing electrical
ality. The induced charge density is proportional to Bω
applied magnetic field, ω = angular velocity of the disc). Then,
a more fundamental approach, the Boltzmann equation for the
day disc is solved. This extends Sommerfeld's work on metals
magnetic field to the case of moving metals.

3160 ON THE FLOW OF A HYDROMAGNETIC FLUID NEAR AN OSCILLATING FLAT PLATE.

Ong and J.A.Nicholls.

ero/Space Sci., Vol. 26, 313-14 (1959).

This note considers the MHD flow near an infinite plate which
llates parallel to itself in a perpendicular magnetic field. This
: is an extension of the problem analysed by Rossow [NACA
ı. Note 3971 (1957)]. As in the latter paper, the magnetic field
ssumed constant and the manner in which currents are to be
ed, etc. is left unresolved.

Mathematical Reviews (H.Greenspan)

3161 A NON-STEADY PROBLEM OF MAGNETO-HYDRODYNAMICS.

D.V.Sharikadze.

. Akad. Nauk SSSR, Vol. 138, No. 3, 568-71 (May 21, 1961).
ıssian.

The paper treats the unsteady boundary layer equations for
dimensional flow of an incompressible electrically and
mally conducting fluid in a uniform applied magnetic field
endicular to the boundary. The Prandtl number is taken as
d the induced magnetic field neglected. Two approximate
gral equations for the velocity and temperature are obtained;
e become exact in the limit where a certain smoothing para-
er approaches zero. A formal power series method of solving
e integral equations is given and its convergence investigated.
lish translation in: Soviet Physics—Doklady (USA)].

O.Penrose

3162 EFFECT OF A MAGNETIC FIELD UPON THE STABILITY OF FREE BOUNDARY LAYERS BETWEEN
) UNIFORM STREAMS.

K.Gotoh.

hys. Soc. Japan, Vol. 16, No. 3, 559-70 (March, 1961).

The stability of free boundary-layer flows of a viscous, incom-
ssible, electrically conducting fluid is investigated. It is found
erally that a uniform magnetic field parallel to the steady flows
an effect of stabilizing the flows. When the magnetic field is
k, i.e. when the Alfvén number A is less than unity, the flows
unstable with zero critical Reynolds number ($R_c = 0$). But
n the magnetic field is so strong that $A > 1$, the flows are
lutely stable ($R_c = \infty$) provided $R_m/R > 1$ where R_m is the
netic Reynolds number. For small values of R_m/R, the flows
unstable even for $A > 1$, so long as $(R_m/R)A^2 \ll 1$. It is also
vn that an oblique magnetic field cannot stabilize the flow,
ever strong it may be.

13163 SINGULAR HYPERSURFACES OF ORDER ONE IN RELATIVISTIC MAGNETO-FLUID-DYNAMICS.

G.L.Saini.

Proc. Roy. Soc. A (GB), Vol. 260, 61-78 (Feb. 7, 1961).

The the 4-space of general relativity, there may exist 3-spaces (hypersurfaces), say Σ_3, such as "weak" shock waves, across which the first derivatives of the various physical quantities may be discontinuous, but these quantities themselves are continuous. In the present paper, an analysis is developed for the study of such singular regions when the matter distribution in space-time is an inviscid, infinitely electrically conducting, charged, compressible fluid. In particular, certain relations are derived which are quite characteristic of a typical Σ_3. With the help of these characteristics relations, it is possible to study the various modes of propagation weak shock waves in relativistic magneto-fluid-dynamics. For instance, it is shown that, other than those Σ_3 which are at rest with respect to the fluid, there exist three types of waves. The requirement that the speeds of these waves be less than that of light restricts the constitution of the fluid. It is also observed that, in the null-field case, there are only two types of waves which have a non-zero speed with respect to the fluid, one of these being purely hydrodynamical, i.e. the sound wave. A formula for the speed of sound in a relativistic gas is derived. Further, the explicit form of the jump conditions for the first derivatives of the physical quantities across an arbitrary Σ_3 are obtained, and the usefulness of the various results is indicated. Finally, some particular cases of the general theory are considered in brief.

13164 A MAGNETO-HYDRODYNAMIC STOKES FLOW.

N.Riley.

Proc. Roy. Soc. A (GB), Vol. 260, 79-90 (Feb. 7, 1961).

Considers the slow flow of a viscous, conducting fluid past a non-conducting sphere at whose centre is a magnetic pole. The magnetic Reynolds number is assumed to be small, and the modifications to the classical Stokes flow and the free magnetic pole field are obtained for an arbitrary Hartmann number. The total drag D on the sphere has been calculated, and the ratio D/D_S determined as a function of the Hartmann number M, where D_S is the Stokes drag. In particular

$$(D - D_S)/D_S = \tfrac{37}{210} M^2 + O(M^4) \quad \text{for small } M$$

and

$$(D - D_S)/D_S \sim 0.7205\,M - 1 \quad \text{as } M \to \infty.$$

13165 VARIATIONAL PRINCIPLE IN MAGNETOHYDRO-DYNAMICS.

R.V.Polovin and I.O.Akhiyezer.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 677-8 (1959). In Ukrainian.

13166 ONE-DIMENSIONAL MAGNETOGASDYNAMICS IN OBLIQUE FIELDS.

J.A.Shercliff.

J. Fluid Mech.(GB), Vol. 9, 481-505 (1960).

This is an extension of the author's earlier work (Abstr. 5570 of 1961) to the case where the magnetic field is not perpendicular but oblique to the flow direction. This is still "strictly one-dimensional" flow in the terminology of the earlier paper. Viscosity is neglected but the analysis is carried out for a general, rather than perfect, gas; the conductivity is assumed to be infinite. Simple waves are first considered and well known results are recovered. It is shown that fast and slow compressive simple waves steepen, while simple waves in which the cross-flow magnetic-field component changes sign would not entirely steepen; this cast some light on the existence of "intermediate shocks." Next, steady flows are treated; six processes are identified, including generalizations of the Rayleigh and Fanno processes of ordinary gasdynamics. In each process certain quantities are stationary when the flow speed equals either the fast or slow magnetosonic speed; these are summarized in a table and a graph. The degenerate case of ordinary gasdynamics is also discussed in some detail. Finally, there is a long section on magnetogasdynamic shocks. The discussion is based upon the properties of the Rayleigh lines. Six varieties of shocks are identified: slow, fast, and four kinds of intermediate shocks. Comparison is made in some detail with previous studies by Friedrichs and Kranzer (1958), Helfer (Abstr. 3799 of 1953), Bazer and Ericson (Abstr. 7211 of 1959), Lüst (Abstr. 5523 of 1955) and Cabannes (Abstr. 5570 of 1961).

Mathematical Reviews (W.R.Sears)

MAGNETOGASDYNAMICS AND PROBLEMS OF COSMOGONY.

See Abstr. 12735

13167 CALCULATION OF GASOMAGNETIC SHOCK-WAVE PARAMETERS.

S.A.Kaplan, A.A.Lohvy̆nenko and T.S.Pidstry̆hach.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 438-42 (1959).
In Ukrainian.

An approximate method involving pressures is applied to solve a number of problems on the calculation of the parameters of perpendicular gasomagnetic shock waves. Formulae are obtained for: (a) the density jump; (b) the density jump in the reflected wave; (c) the velocity of the shock wave; (d) the pressure in the compressed region formed by the collision of two magnetized gas masses moving with a relative velocity u_0.

13168 SIMPLE WAVES IN MAGNETO-HYDRODYNAMICS.

A.Y.Akhiyezer, H.Ya.Lyubars'kyi and R.V.Polovin.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 433-8 (1958). In Ukrainian.

The connection is considered between simple and linearized plane waves. All simple waves in magnetohydrodynamics are found. It is shown that in magnetohydrodynamics, as in ordinary hydrodynamics, the region of constant flow may border only on a simple wave in the absence of shock waves.

13169 GROWTH OF HYDROMAGNETIC SHOCK WAVES.

I.J.Singh and K.P.Chopra.
Indian J. Phys., Vol. 35, No. 4, 199-210 (April, 1961).

The influence of a transverse magnetic field is considered on the formation of a shocks wave in an electrically conducting field. It is concluded that the presence of the transverse field is conducive to the growth of compression waves and the decay of the expansion waves.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

13170 PERIODIC SOLUTIONS OF THE WAVE EQUATION WITH A NONLINEAR INTERFACE CONDITION.

W.L.Miranker.
IBM J. Res. Developm. (USA), Vol. 5, No. 1, 2-24 (Jan., 1961).

Considers the problem of the voltage oscillations in a transmission line when a diode represented as a nonlinear capacitance is placed in shunt in that line, in particular the response of this line to periodic driving voltages and the periodic responses. This physical situation is shown to lead to the mathematical model of the wave equation in the voltage in a domain with an internal boundary (the interface), at which the voltage is required to satisfy a nonlinear jump condition. By an application of Gauss' theorem, the problem is reduced to a nonlinear difference-differential equation. In the case that the generator driving the line is matched to it, this family of equations reduces to a family of nonlinear differential equations. The paper is concerned with a study of the periodic solutions of these two classes of equations.

13171 GENERATION OF HIGH POWER RADIO-FREQUENCY PULSES BY MEANS OF AN EXPLODING WIRE TECHNIQUE.

I.R.Jones and R.F.Wuerker.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 962-3 (Aug., 1961).

The method utilizes the "current dwell" period which can occur when a thin wire is exploded by means of a high current. The r.f. oscillation occurs in a resonant circuit placed in series with the exploding wire. A circuit is described in which is obtained a 6 μsec duration pulse of 2.74 Mc/s.

13172 SOME APPLICATIONS OF A MASER OSCILLATOR FUNCTIONING AT HIGH FIELDS.

C.Fric.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 640-4 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). It is shown how measurements of the change in frequency of oscillation of the maser enable one to measure the relaxation time T_2 of a moving liquid, and the value and time stability of the magnetic induction. Also it is shown how the oscillator output may be used to control the value of the induction.

J.M.Baker

13173 MASER-ACTION IN THE OPTICAL RANGE AND POSSIBILITY OF ABSOLUTE NEGATIVE ABSOR IN CERTAIN MOLECULAR SPECTRA (THE "LIGHT-AVALA

F.G.Houtermans.
Helv. phys. Acta (Switzerland), Vol. 33, No. 8, 933-40 (1960).
In German.

It is pointed out that many molecular systems in which th upper state radiates to an intermediate dissociating level, wh negligibly populated, automatically fulfil the conditions for th level maser action. The case of the energy levels involved in emission of the "hydrogen continuum" from H_2 is discussed i detail. Spectral distribution of the emission is considered, a approximate expressions for the negative absorption coefficie derived on the basis of simplifying assumptions. Further sui cases of dissociating spectral systems are discussed.

J.S

13174 MASER ACTION IN EMERALD.

F.E.Goodwin.
J. appl. Phys. (USA), Vol. 32, No. 8, 1624-5 (Aug., 1961).

A maser was successfully operated as an amplifier at 10 Details of cavity, crystal and full particulars of operation are The pump frequency was 58.4 kMc/s and the bandwidth was 20 for 20 dB gain.

A.P.C

13175 "NON-ADIABATIC" BEHAVIOR IN A LOW FREQUENCY BEAM-TYPE MASER.

T.Shimizu and K.Shimoda.
J. Phys. Soc. Japan, Vol. 16, No. 4, 777-91 (April, 1961).

Characteristics of a low frequency beam-type maser are discussed. A particularly interesting phenomenon is a breakd of the adiabatic focusing approximation. Theories of electros focusing and the linewidth of the low frequency transition are obtained by taking into consideration the effect of transition induced by the Stark field which changes with time on a movin molecule. Saturation of the effective number of focused mole with the focuser voltage is calculated. The induced radiofreq transition of a molecule in a mixed state is calculated and the shape is shown to be the same as for a molecule in a pure sta

SPATIAL COHERENCE IN THE OUTPUT OF AN OPTICA MASER. See Abstr. 12997

13176 REFLEX KLYSTRON AS A HIGH SPEED MICROW SWITCH.

B.G.Whitford.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 919-21 (Aug., 1961).

Nanosecond switching of r.f. power is achieved using a re klystron in a nonoscillating state for amplitude modulation. T variation of klystron input admittance with reflector potential used. A review of reflex klystron theory is presented explain the technique. Experimental work at X band using a hybrid T separate reflected power from power incident on the tube sho that flat-topped r.f. pulses with rise time of 1.5 nsec and deca time of 6 nsec are possible. Switch "off" relative to switch " attenuation of 30 dB was obtained with a reflector voltage swing 10 V. It is believed that the technique is applicable at any fre where reflex klystrons are available.

13177 GENERALIZED COUPLED MODE THEORY.

M.C.Pease.
J. appl. Phys. (USA), Vol. 32, No. 9, 1736-43 (Sept., 1961).

The pairwise coupling of modes in distributed systems su the travelling-wave parametric electron-beam amplifier and other types is shown to permit only two types of interaction. type, called β-coupling, results in the periodic interachange o signal between the modes, as typified in the Kompfner-null co The other, γ coupling, results in the exponential growth of the as in the travelling-wave tube and in the pump section of a pa metric amplifier. The nature of the resultant interaction is a consequence of the underlying relations contained in the conse law that that applies throughout the system, i.e., in the separa parts of the system and that is independent of the various cou coefficients. The "rank" and "signature" of the metric that expresses this conservation law is sufficient to determine the of behaviour. The direction of flow of energy in the coupled n imposes a duality on these relations. Where modes of opposi directionality are coupled, β coupling causes system amplific while γ coupling causes system interchange. These relations generalizations of effects that have been studied in detail for specific systems. They are not, however, consequences of th details of the system but are, rather, the only alternatives po assumptions that are broad in scope and generally applicable ices of interest.

.78 CALCULATION OF THE PROPAGATION COEFFICIENTS OF MODES PROPAGATING IN A RECTANGULAR
LOADED WITH A THIN FERRITE PLATE MAGNETIZED
SVERSLY. J.L.Dormann.
Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 118-22 (Sept., 1960).
nch.

th Colloque Ampère Paper (see Abstr. 4734 of 1961). The e plate is mounted off-axis in the E-plane, is infinite in the ion of propagation and occupies the full height of the guide. pression for the propagation constant of the system is derived ing simple sinusoidal variation of magnetic field components, a conventional electromagnetic theory approach. Solution of pression is not attempted. See also following abstract.

G.D.Sims

.179 CALCULATION AND MEASUREMENT OF THE ATTENUATION DUE TO A THIN MAGNETIZED
ITE PLATE PLACED IN A RECTANGULAR GUIDE AT 3.7Gc/s.
ormann.
Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 123-6 (Sept., 1960).
ench.

th Colloque Ampère Paper (see Abstr. 4734 of 1961). The m considered is the same as that of the preceding abstract. st order expression determining the propagation constant is oped and it is shown to be verified under conditions of small te thickness by plotting guide attenuation against thickness as ction of the displacement of the ferrite from the axis of the .

G.D.Sims

180 ELECTROMAGNETIC SURFACE WAVES ON A PLANE INTERFACE. B.A.Lengyel and K.M.Mitzner.
. Phys. (USA), Vol. 32, No. 9, 1758-63 (Sept., 1961).

Surface waves are defined as waves exponentially decreasing th sides of a plane interface. It is shown how all such waves e generated from a single Hertz vector perpendicular to the face. The relations between the propagation parameters of aves and the material constants are derived in a general case h includes media with different magnetic permeabilities. The ition for the existence of surface waves is derived.

181 FRAUNHOFER DIFFRACTION OF AN ELECTROMAGNETIC WAVE. B.Karczewski.
t. Soc. Amer., Vol. 51, No. 10, 1055-7 (Oct., 1961).

Kottler's theory (1923) is specialized for application to nhofer diffraction. The predicted electromagnetic field is sverse in the Fraunhofer region and agrees with that obtained Kirchhoff's scalar theory for directions of propagation along ar the direction of the central maximum. The notation of the acted electromagnetic wave is introduced and discussed.

CLOSED SOLUTIONS OF RAYLEIGH'S DIFFRACTION
GRAL FOR AXIAL POINTS. See Abstr. 12968

182 THE SCATTERING OF ELECTROMAGNETIC WAVES BY TURBULENT PULSATIONS, TAKING INTO
OUNT THE AVERAGE FLOW CURL. V.I.Mȳkhailov.
yin. fiz. Zh. (USSR), Vol. 3, No. 3, 351-7 (1958). In Ukrainian.

Two models are considered which permit one to take into nt the possible effect of the average flow curl on the lence spectrum F(k, t). A first approximation expression is ned for the scattering cross-section, including the case when t) is an arbitrary positive power of k.

MICROWAVE ATTENUATION BY CYCLOTRON RESONANCE
SLIGHTLY IONIZED GAS. See Abstr. 13087

STEPPED WAVEGUIDE TRANSFORMERS AND FILTERS.
bstr. 12943

183 THE PHASE STRUCTURE OF THE FIELD AND VELOCITY OF MEDIUM RANGE RADIOWAVE DISTRI-
ION OVER THE SEA SURFACE DURING TURBULENCE.
Herman.
yin. fiz. Zh. (USSR), Vol. 3, No. 6, 712-20 (1958). In Ukrainian.

The unevenness of the sea surface during turbulence leads to nge in the phase structure of the field and the phase and lium" velocities of radiowave propagation. This is physically connected with changes in the boundary field value due to resulting non-uniformities. The integral equation of Feinberg for a medium with effective parameters is necessary for the mathematical investigation of this effect. The attenuation function Φ obtained on solving this equation is given. The characteristic length $\lambda^3/h^2(hL^{-1})^2$, which depends on the squares of the average height and steepness of the sea waves $[h^2,(hL^{-1})^2]$ and the radio-wavelength λ, and not on the conductivity and dielectric constant of the real medium. The values Φ and arg Φ are tabulated. The value of the relative change of phase

$$\delta\varphi = \frac{\varphi}{K\chi} = \frac{1}{2\pi u}\varphi(u)\frac{\lambda}{\Lambda} \cong \frac{\lambda}{\Lambda} \cong h^2\frac{(hL^{-1})^2}{\lambda^2}$$

may vary from several per cent to fractions of 1% in the medium wavelength range, depending on h and λ. Since the phase change $\delta\varphi$ theoretically varies with the distance, the phase measurements, carried out simultaneously with the field amplitude measurement, permits the experimental checking of the theory. The value of Λ, defined by the experimental value of the amplitude $|\Phi|$, should approximately agree with the characteristic length Λ determined by phase measurements. This condition should be satisfied during turbulence of various intensity for various radio-wavelengths. It is expedient, here, to measure $\varphi(u)$ experimentally. The relative change in phase and "average" velocity of radio-wave propagation over the sea during turbulence should reveal a qualitatively distinct correlation with the value

$$\frac{\varphi(u)}{2\pi u}\frac{\lambda}{\Lambda},\ \frac{1}{2\pi}\frac{d\varphi(u)}{du}\frac{\lambda}{\Lambda} \sim \frac{h^2(hL^{-1})^2}{\lambda^2}$$

which does not practically depend on the distance (on the assumption of uniformity of sea turbulence along its path). The possible error in determining the phase and "average" velocity, due to turbulence of the sea, decreases with an increase in wavelength and a reduction in the average height and steepness of the waves.

PROPAGATION AND GENERATION OF LOW-FREQUENCY ELECTROMAGNETIC WAVES IN THE UPPER ATMOSPHERE.
See Abstr. 12694

Radiofrequency Spectroscopy Techniques

13184 RADIOPHYSICS CONFERENCE AT PISA. D.J.E.Ingram.
Phys. Today (USA), Vol. 14, No. 4, 48-9 (April, 1961).

An account of the ninth Ampère Colloquium. See Abstr. 4734 of 1961.

13185 MICROWAVE INTERFEROMETER WITH COHERENT BACKGROUND. A.Boivin and R.Tremblay.
Canad. J. Phys., Vol. 39, No. 3, 393-408 (March, 1961). In French.

The interferometric features of a microwave apparatus for the study of diffraction images are described, using a turnstile aerial as a detector. Phases can be measured with an error of ±1°. Because of the simple construction measurements can easily be made subject to theoretical analysis. The simplicity makes the device suitable for millimetre waves.

F.Bruin

13186 A HIGH POWER MICROWAVE SPECTROGRAPH (AMPLITUDE MODULATED AND FREQUENCY STABILIZED) FOR DIVERSE APPLICATIONS. J.Pescia.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 350-3 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). An apparatus is described for performing paramagnetic and ferromagnetic resonance experiments with high frequency modulation. The z-component of magnetization is detected and the resonance lines are displayed directly on the oscilloscope.

P.E.Seiden

13187 BEAM-TYPE MASERS FOR RADIOFREQUENCY SPECTROSCOPY. K.Shimoda, H.Takuma and T.Shimizu.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2036-41 (Nov., 1960).

The theoretical estimate of sensitivity is discussed and a table of minimum detectable beam intensity and estimate of available beam intensity for some of the low-frequency transitions is given. A K-type doubling transition, $4_{31} \rightarrow 4_{32}$, of formaldehyde was observed as an emission line at 4.5769 ± 0.0023 Mc, and compared with the theories. The observed saturation in focusing is probably due to the non-adiabatic change of rotational states in the focuser. The saturation broadening of the line with increasing r.f. field shows agreement with theory.

13188 MICROWAVE PHASE-SHIFTER WITH DIELECTRIC PRISMS. R.Tremblay.

Canad. J. Phys., Vol. 39, No. 3, 409-18 (March, 1961). In French.

A tapered phase-shifter for waveguides, analogous to an optical construction, is described. The dielectric slab consists of two prisms, which, by relative sliding, vary the optical length. A phase shift of 0.7° and a s.w.r. of 1.05 can be observed. F.Bruin

13189 ON THE THEORY OF THE HYPERFINE STRUCTURE OF ELECTRON SPIN RESONANCE SPECTRA.

I.V.Aleksandrov.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 679-80 (Nov., 1960). In Russian.

Extends a method of calculating nuclear magnetic resonance spectra (Abstr. 1279 of 1961) to determination of the hyperfine structure of electron spin resonance spectra when the ground state of an unpaired electron is near-degenerate because of symmetry conditions. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 359 (Nov., 1960)]. A.Tybulewicz

13190 THE APPLICATION OF PARAMAGNETIC RESONANCE TO NON-DESTRUCTIVE TESTING. J.W.Orton.

Progress in non-destructive testing, Vol. 2 (see Abstr. 9239 of 1961) p. 223-50.

The theory of paramagnetic resonance is outlined and the basic experimental techniques are described. Results and applications to chemical analysis, metallic conductors, organic compounds, radiation damage and colour centres are discussed and possible industrial applications are suggested. 51 references. J.B.Birks

13191 HIGH FREQUENCY MODULATION IN ELECTRON MAGNETIC RESONANCE.

J.G.Theobald and J.Uebersfeld.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 347-9 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A method for modulating the d.c. magnetic field in paramagnetic resonance experiments is described which permits modulatio frequencies from 100 kc/s to 1 Mc/s by means of a modulatio placed inside the microwave cavity. A sweep of 40 Oe was obt at 1 Mc/s with a factor of 30 improvement in the signal-to-no ratio over modulation at 50 c/s. P.E.S

13192 THE MEASUREMENT OF INDIRECT COUPLING A CHEMICAL SHIFT USING SPIN ECHOES.

J.G.Powles and A.Hartland.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 474-9 (1960

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A technique of nuclear magnetic resonance is briefly discribed, involving the use of a 90°, τ, 180°, 2τ, 180°, ... sequence of pul which greatly reduces the attenuation of spin echoes by self-diffusion effects. The method therefore allows the observatio several periods of the echo amplitude modulation which occurs when chemical shifts or indirect spin—spin couplings are pres The accuracy of determination of coupling constants may be gre than that attained in steady state measurements. E.F.W.Sey

13193 SOME NEW STRUCTURAL AND ANALYTICAL APPLICATIONS OF HIGH-RESOLUTION N.M.R.

J.N.Shoolery.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 495-505 (19 In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A description, with examples, is given of the employment of the information made available by the technique of electronic integ tion of the areas of n.m.r. lines (a) in understanding the struct of large complicated molecules the spectra of which are not co pletely resolved, (b) in obtaining accurate values of the perc .. by weight of hydrogen in an organic substance (to better than o percent for a 25 mg sample), of the numbers of hydrogen atom present in the molecule, and hence of the molecular weight. E.F.W.Se

NUCLEAR RESONANCE EXPERIMENTS WITH A FLOWIN LIQUID. See Abstr. 12904

SOME PROPERTIES OF RESONANCE LINE-SHAPE FUNCTIONS. See Abstr. 12247

NUCLEAR PHYSICS

13194 THE BIRMINGHAM CONFERENCE ON NUCLEAR PHYSICS, APRIL 1961.

W.E.Burcham, G.H.Burkhardt and P.M.Rolph.

Brit. J. appl. Phys., Vol. 12, No. 9, 425-8 (Sept., 1961).

The Institute of Physics and The Physical Society held a conference on nuclear physics in the Departments of Physics and Mathematical Physics of the University of Birmingham on 17th, 18th and 19th April 1961. The subject matter discussed covered a wide field of experimental and theoretical research.

13195 STATISTICAL PROBLEMS IN NUCLEAR AND COSMIC RAY PHYSICS. J.E.Moyal.

Bull. Inst. Internat. Statist., Vol. 35, No. 2, 199-210 (1957).

Making use of the fact that many of the individual nuclear and atomic events taking place when radiation passes through a bulk medium are statistically independent; the author sets up the Chapman—Kolmogoroff equation describing the Markoff process. Forward and backward intergrodifferential equations are then obtained and a generalized solution in iterative form is given. The illustrative examples of multiple scattering and the development of a nucleon cascade in homogeneous nuclear matter are discussed. Mathematical Reviews (H.Messel)

APPARATUS

PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

13196 CHARACTERISTIC PARAMETERS OF GEIGER—M COUNTER GASES. I. ETHANOL—ARGON MIXTU

C.D.Storrs and R.W.Kiser.

Appl. sci. Res. B (Netherlands), Vol. 8, No. 4, 387-96 (1960).

The Wilkinson and the Diethorn—Kohman expressions of c operation are reviewed. In equating these two expressions, th amplification factor is taken to be 10^7 at the starting potential Geiger operation of the counter. Although the use of this nume value has not yet been completely verified, the use of a consta established from the results obtained for the five different eth argon mixtures examined in this work. The variation of the ch eristic parameters with gas composition is shown to be in gen accord with the theory being formulated.

13197 THE USE OF CYCLOPROPANE VAPOUR IN GEIGER—MULLER COUNTERS. D.Blanc and J.C

J. Phys. Radium (France), Vol. 21, Suppl. No. 7, 92A-96A (July, 1960). In French.

Externally graphited glass counters, filled with cyclopropa and argon have a plateau length of 100-200 V and dead times h

hose given by argon and methylal fillings under the same
ures. However, the cyclopropane pressure must be above
of mercury, for the slope of the plateau curve to be less than
r 100 V. Pure cyclopropane vapour will give very long
u curves (length > 600 V) with a very smooth slope
per 100 V), with pressures between 25 and 30 cm of mercury.
gamma-rays (1 MeV), the efficiency is equivalent to that
ed with the usual fillings of argon and polyatomic vapour.
ery times of detectors filled with mixtures of argon and
propane have been evaluated by the oscillographic method, to
e the k_c value of the mobility of cyclopropane ions. Under
pheric pressure:

$$k_c = 0.87 \pm 0.05 \text{ cm}^2 \text{ s}^{-1} \text{ V}^{-1}.$$

obility k_a of argon ions has been calculated in the same way.
atmospheric pressure:

$$k_a = 1.30 \pm 0.05 \text{ cm}^2 \text{ s}^{-1} \text{ V}^{-1}.$$

ar measurements made with pure cyclopropane confirm that
ever formula remains valid for such fillings, and give for
identical value, within experimental errors.

198 CHARACTERISTICS OF KRYPTON COUNTERS.
T.Suzuki, J.Yuhara and T.Majima.
ys. Soc. Japan, Vol. 15, No. 9, 1702 (Sept., 1960).

he behaviour of krypton counters containing either ethylene or
ne as quenching agents was studied as a function of the partial
ures of the gases. It was found that counters containing
ne have good self-quenching properties for all partial press-
of the krypton, provided that the partial pressure of the ethylene
ween 17.5 and 33 mm Hg. Methane was found to be ineffective
uenching agent. These facts are accounted for by the ioniza-
otential of krypton being greater than that of ethylene but less
hat of methane. J.L.Redding

199 CO_2—CS_2 GEIGER COUNTER.
H.R.Crane.
sci. Instrum. (USA), Vol. 32, No. 8, 953-62 (Aug., 1961).

xperiments on the mechanism and characteristics of a
CS_2 Geiger counter are reported, and circuits and methods
eration which satisfy the special requirements are described.
ctive part of the counter is $2\frac{7}{8}$ in. in diameter and 16 in. long,
to 1 atm, 95% CO_2 and 5% CS_2. The cathode is copper and the
is 0.005 in. diameter Chromel A. The electrons released by
izing particle become attached, probably to CS_2. The self-
hing action of the counter is excellent, no spurious counts
observed in the absence of electronic quenching. However,
d time of several milliseconds must be imposed electronically
se of the long interval during which the negative ions arrive
anode. An electronic quench is used which is triggered both
CO_2—CS_2 counter and the anticoincidence ring. This serves
pose the required dead time and also to prevent the firing of
—CS_2 counter by mesons. The plateau was measured to
V above threshold and was found to be level to within 1% from
1600 V above threshold. The maximum drift time of the
ive ions was found to be about 9 msec with a sharp cutoff.
with various combinations of gas indicated, but did not prove,
he charge carrier was CS_2. The effects of common contamin-
vere determined. At voltages over 400 V above threshold, 1%
ve no detectable effect; 0.3% SO_2 gave a 2 to 3% reduction in
ing rate. Extensive tests of the efficiency was made. Com-
ons of the CO_2—CS_2 filling with an argon—ethane filling gave
cal results within the experimental error. No basis was found
pposing that there was any failure of the CO_2—CS_2 counter to
er counts. The counter described has been used for C^{14} dating
ses over a long period of time. There has been no indication
here are variations in counting rate outside those expected on
sis of statistics. The counting rate for "dead" CO_2 in an iron
9 in. thick and after anticoincidence is 8 per min.

3200 NOTE ON THE EFFECTS DUE TO PULSE-DELAY PHENOMENA IN $CO_2 + CS_2$ G—M. COUNTERS.
ścicki.
phys. Polon. (Poland), Vol. 20, No. 1, 59-65 (1961).

he use of $CO_2 + CS_2$ G—M counters has yielded half-lives for
fferent from those obtained using argon—alcohol counters. The
r shows that delay between the passage of an ionizing particle
e appearance of the pulse is responsible for the different
s obtained and shows how to correct the results obtained. The
obtained by Miller [Rev. sci. Instrum (USA), Vol. 18, 496
(1947)] is reduced from 6100 to 5864 ± 200 yr and that obtained by Hawkings et al (Abstr. 7220 of 1949) from 6320 ± 200 to 6040 ± 300 yr. J.L.Redding

13201 LOW-VOLTAGE HALOGEN COUNTERS (MECHANISM OF DISCHARGE).
V.V.Vishnyakov, Tan Syao-Vei [T'ang Hsiao-Wei] and A.A.Tyapkin.
Uspekhi fiz. Nauk (USSR), Vol. 72, No. 1, 133-52 (Sept., 1960).
In Russian.

Discusses in detail (a) the time development of the non-self-maintaining discharge, (b) that of the self-maintaining discharge and the time distribution of pulse delays, and (c) the near-threshold oscillations of the discharge. The pulse delay time is proportional to the mean lifetime of the halogen metastable atoms and increases with decreasing overvoltage. The sharp decrease in efficiency at low operating voltages is attributed to negative ions surviving breakup in the high-field region near the wire. A decrease in efficiency is observed after heating the counters at 120°C for an hour. A unified explanation of the properties of these counters is given on the basis of the time development of the discharge governed by ionization produced by collisions of the second kind. [English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 5, 765-77 (March-April, 1961)]. I.C.Demetsopoullos

13202 ON THE TEMPERATURE ACCOMMODATION OF SELF QUENCHING G.M. COUNTERS.
A.Peeva and T.Karatoteva.
C.R. Acad. Bulg. Sci., Vol. 14, No. 1, 15-18 (1961).

Shows that good characteristics with G.M. tubes are obtained provided the temperature around the anode is stable.
R.H.Thomas

13203 TEMPERATURE STABLE REGION AND AGEING OF THE SELF-QUENCHING G.M. COUNTERS.
A.Peeva and T.Karatoteva.
C.R. Acad. Bulg. Sci., Vol. 14, No. 2, 135-8 (1961).

Shows that any alcohol-quenched Geiger counter will have a stable temperature region in which a good plateau may be obtained. The lower limit of this temperature region increases with the length of period of operation of the tube and the tube will possess no stable temperature region after hemisorption sets in.
R.H.Thomas

13204 THE DESIGN AND APPLICATIONS OF A DEMOUNTABLE 4π GEIGER—MULLER COUNTER.
L.K.Burton and N.G.Trott.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 1, 20-8 (May, 1960).

An improved 4π G.M. counter has been designed from which the cathode can be easily removed, leaving the anode wires intact and still under tension. Counters of this type have been used successfully for several years in the measurement of radioactive nuclide standards and results of intercomparisons of standards with other laboratories are presented. The counters have also been used in conjunction with γ-ionization measurements in determining the specific γ-ray emission (k-factor) for Fe^{59}, Cs^{137} and Ir^{192}. Applications of these counters in biological and medical work are described.

13205 A SIMPLE HODOSCOPIC RECORDER.
D.Tinturier.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 173A-175A (Nov., 1960). In French.

A commercial recorder making use of inkless electric writing on metallized paper was altered and made suitable for recording the events detected by a hodoscope of Geiger—Müller counters. The apparatus is simple, reliable, requires very little energy and is capable of recording over long periods of time.

13206 GAS AMPLIFICATION IN PROPORTIONAL COUNTERS.
S.Ramakrishna.
Proc. Indian Acad. Sci. A, Vol. 51, No. 2, 117-22 (Feb., 1960).

The variation of gas amplification with applied voltage was studied for argon quenched with ethane and carbon dioxide. The effects of pressure, quenching agent and concentration on the gas amplification factor are discussed briefly.

13207 A DETECTING SYSTEM FOR SCATTERING STUDIES.
R.Chaminade, M.Cros, M.Crut and A.Papineau.
J. Phys. Radium (France), Vol. 21, No. 5, 396-8 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The principal features are described of the detectors used in scattering experiments with 44.4 MeV alpha-particles, and the associated electronics engaged in the particle selection.

13208 A BETA—GAMMA IONIZATION CHAMBER FOR SUB-STANDARDS OF RADIOACTIVITY. I. USES AND CALIBRATION.
J.W.G.Dale, W.E.Perry and R.F.Pulfer.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 65-71 (April, 1961).

The paper gives information on the construction, characteristics and calibration of the type 1383 A chamber for the guidance of users. This instrument is a combination of a re-entrant cylinder (well-type) gamma-ray chamber with an approximately "2π" beta-ray chamber which in conjunction with a d.c. amplifier or electrometer, is suitable for the measurement of samples of γ-emitting and β-emitting isotopes. The γ-ray and β-ray ionization currents and the background are of the order of 10^{-11}, 10^{-10} and 10^{-14} A/mc, respectively. The calibration figures for standard Na^{24}, P^{32}, K^{42}, Fe^{59}, Co^{60}, Br^{82}, Y^{90}, Au^{198} and Ra^{226} sources and the correction factors applicable to measurements of solutions in 2 ml ampoules, and 10 ml bottles are given.

A BETA—GAMMA IONIZATION CHAMBER FOR SUB-STANDARDS OF RADIOACTIVITY. See Abstr. 13208

13209 A BETA—GAMMA IONIZATION CHAMBER FOR SUB-STANDARDS OF RADIOACTIVITY. II. INSTRUMENT RESPONSE TO GAMMA RADIATION. J.W.G.Dale.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 72-8 (April, 1961).

The paper describes a method of calculating the response to gamma radiation of the type 1383 A chamber for those isotopes whose gamma energies lie within the range 0.2-3.0 MeV. The instrument response is expressed as current per millicurie for each isotope. An allowance is made for the effect on response, especially at lower energies, of the materials from which the instrument is constructed. Estimates of current per millicurie produced by this method have been shown by subsequent experimental calibrations to lie, with few exceptions, within ±3% of the experimental values. Activity estimates may therefore be made with reasonable precision where no absolute method (such as 4π proportional counting) is available or a very short half-life precludes its use.

13210 THICK-WALLED IONIZATION CHAMBER FOR MEASURING γ-RAY INTENSITY UP TO 100 MeV.
G.Bussetti.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 63-6 (1961). In Italian.

An aluminium thick-walled ionization chamber suitable for measuring the radiation intensity from synchrotrons and betatrons at energies up to 100 MeV is described. Curves giving the chamber sensitivity for γ-radiation of given frequency as function of the current in the chamber are reported. In the calculation the effects of the secondary Compton photons produced in the walls from the incident beam are considered.

APPLICATION OF IONIZATION CHAMBERS TO THE MEASUREMENT OF THE INTENSITY OF GAMMA-RADIATION. See Abstr. 13378

13211 THE DOUBLE-GRID IONISATION CHAMBER. I.Ogawa and T.Doke.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1025 (May, 1961).

In a single-grid ionization chamber simultaneous extraction of pulses from collector and grid impairs the shielding efficiency of the grid and reduces the energy resolution. This effect is avoided by the use of a second earthed grid used as a screen between the collector and first grid. J.L.Redding

13212 INFLUENCE OF THE HUMIDITY ON THE SPARK FORMATION IN ROSENBLUM COUNTERS.
L.Daddi and L.de Franceschi.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 9, No.1-4, 132-3 (Dec., 1960).

13213 AN IMAGE INTENSIFIER SPARK TUBE. M.Inoki.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 994-5 (Aug., 1961).

It is suggested that an image intensifier tube in which the phosphor end screen is replaced by a shallow, very thin walled spark chamber, would enable one to detect photo-electrons with an efficiency of about 50%, and a position determination within ± 1mm. J.L.Redding

13214 LIQUID SCINTILLATION COUNTING OF α-PARTI
AND ENERGY RESOLUTION OF THE LIQUID
SCINTILLATOR FOR α- AND β-PARTICLES. H.H.Seliger.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 1, 29
(May, 1960).

The experimental conditions are determined for the absolu
counting of α-particles in the liquid scintillator. Results are c
pared with those obtained by 4π gas proportional counting. Fr
analysis of the pulse height distributions obtained for Po^{210} α-
particles and Ba^{137} conversion electrons it was possible to calc
a conversion efficiency in the liquid scintillator of approximate
1 photon per 125 eV for β-particles and 1 photon per 1400 eV fo
α-particles. A further analysis of the phototube noise spectru
shows that the observed phototube noise pulses are primarily c
to photocathode emission of single electrons.

13215 A NEW TYPE OF LIGHT-TIGHT HOUSE FOR α-SCINTILLATION COUNTERS.
V.Hollstein and H.J.Akkerman.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 1, 60
(May, 1960).

The sample is rotated between filling and counting positio
The penetration of light onto the photomultiplier is prevented u
all circumstances by a simple locking mechanism. The efficie
of the counter is 47% and the background is 0.1 counts/min.
J.L.Re

13216 A LIQUID SCINTILLATION COINCIDENCE COUNT
FOR RADIOCARBON. K.J.Nygaard.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 89-92 (1961).

Measurements were made of the radiocarbon counting per
formance of a liquid scintillation coincidence counter used in c
junction with an anticoincidence shield counter. When operate
room temperature, the system has a radiocarbon counting effi
of 59% at a background of 16 counts/min. The activity of ethan
made from contemporary wood was determined to 13.1 ± 0.6
disintegrations per minute per gram of carbon.

13217 DETERMINATION OF LIQUID SCINTILLATION CO
ING EFFICIENCY BY PULSE HEIGHT SHIFT.
L.A.Baillie.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 1, 1-
(May, 1960).

A method was developed by which liquid scintillation count
efficiency can be determined simultaneously with the count. T
two scalers of a liquid scintillation spectrometer are set to co
simultaneously different parts of the spectrum. The ratio betw
the counts on the two scalers can be used as an accurate index
the counting efficiency on one of them. This method saves con
able time compared with the conventional internal standard me
and appears to be of equal or greater accuracy.

13218 A LARGE-VOLUME 4π LIQUID SCINTILLATION
DETECTOR. B.G.Dunavant and J.E.Christian.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 2
(Oct., 1960).

This detector has a scintillator volume of 1 ft^3 and a samp
chamber 4½ in. in diameter and 8 in. long. Four 5 in. photomul
tubes give a photocathode coverage of about 10% of the detecto
wall area. Good light collection efficiency results in the count
being relatively insensitive to source position in the sample ch
The detector is housed in an iron shield providing 5 in. of shie
Such detectors as the one described should find wide applicatio
particularly in biological studies and clinical diagnosis.

13219 LIQUID SCINTILLATION COUNTING OF TRIATED
WATER. J.F.Cameron and I.S.Boyce.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4,
228-9 (Oct., 1960).

Discusses the origin of background counts from liquid
scintillation counter arrays used in counting tritiated water. T
advantages in cooling the photomultiplier or using two tubes in
coincidence are also discussed. R.H.Th

13220 A SIMPLE PLASTIC SCINTILLATION COUNTER
TRITIATED HYDROGEN.
I.S.Boyce, J.F.Cameron and K.J.Taylor.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4,
122-3 (Dec., 1960).

This detector is designed to measure the tritium content
hydrogen coming from a palladium chromatography column.

221 EFFICIENCIES AND PHOTOFRACTIONS OF SOME COMMONLY USED NaI(Tl) WELL CRYSTALS.

Jablo and T.C.Martin.
nat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 55-60
., 1961).

3222 THE USE OF CsI(Tl) CRYSTAL FOR THE DETERMINATION OF ABSOLUTE GAMMA EMISSION RATES.

Srivastava and U.C.Gupta.
i. industr. Res. (India), Vol. 20B, No. 6, 243-6 (June, 1961).

A single-channel scintillation spectrometer with a CsI(Tl)
al as detector was used for the determination of absolute
na emission rates of some radionuclides. The absolute
iency of a cylindrical CsI detector (1 in. thick and 1.5 in. dia-
r) is calculated for gamma-ray energies from 0.1 to 5 MeV
oint sources situated on the axis of the detector. Peak-to-total
for the detector was also measured.

3223 MEASUREMENT OF THE TIME DEPENDENCE OF SCINTILLATION INTENSITY BY A DELAYED-
ICIDENCE METHOD. L.M.Bollinger and G.E.Thomas.

sci. Instrum. (USA), Vol. 32, No. 9, 1044-50 (Sept., 1961).

A new method of measurement is described. An important
ct of the method is the ease with which it can be applied to
nodes of excitation. The results of measurements for several
es of excitation are presented.

A TRANSISTORIZED EQUALIZER FOR FAST COINCIDENCE
K WITH SCINTILLATION COUNTERS. See Abstr. 13055

3224 ON THE SIMULATION OF A SYNCHRO-CYCLOTRON PARTICLE BEAM BY MEANS OF A LIGHT MODULATOR.

rnigoi, I.Gabrielli and G.Iernetti.
o Cimento Suppl. (Italy), Vol. 16, No. 2, 256-8 (1960).

n order to investigate the behaviour of conventional plastic
illator telescopes exposed to a particle beam, their operating
tions can be simulated using light modulated in intensity. By
s of ultrasonic standing waves a repetition of short light
s is obtained, so as to simulate the light emitted by the scintill-
during the duty-cycle of a machine. At a pulse repetition-rate
Mc/s the light pulses present a width at half-amplitude of
ec. By splitting the modulated light beam as to hit two or more
multipliers, it is possible to test the whole electronic equipment
ed to a telescope.

3225 AN AUTOMATIC CHANGER FOR LIQUID SAMPLES. H.de Waard.

nat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3,
41 (July, 1960).

In radiochemical and radiomedical work the γ-activity of liquid
les is usually determined with the aid of a well-type NaI-
illation counter. If large numbers of samples must be dealt
manual handling of test-tubes and lead shielding becomes
us and time consuming. In order to eliminate this labour
natic changers for well-type counters have been developed.
s note another instrument of this kind is described, which can
le up to 50 samples. In radiochemical work the changer can
ltaneously be used as a fraction collector, e.g. in combination
an ion-exchange column.

3226 CONSTRUCTION AND TEST OF A COMPRESSED-GAS CHERENKOV COUNTER. STUDY OF THE CONTAM-
TION OF A BEAM [OF MESONS].

oc, J.Banaigs and J.F.Detoeuf.
ys. Radium (France), Vol. 22, Suppl. No. 2, 64A-67A
., 1961). In French.

3227 A CHERENKOV GAS COUNTER WITH EFFICIENCY NEAR UNITY.

eneventano, E.De Agostino, B.Rispoli and A.Serra.
o Cimento Suppl. (Italy), Vol. 16, No. 2, 159-67 (1960).
lian.

Measurements of the efficiency of a gas-filled Cherenkov
ter are given. The efficiency, taking into account the spectrum
smic-ray muons of momentum greater than 1.75 GeV/c, as a
ion of the gas pressure is (97.10 ± 0.50)% at 8.1 atm. The
iency for particles having $\beta = 1$ should be F(c) = (99.45 ± 0.06)%
atm.

3228 TOTAL ABSORPTION LEAD GLASS ČERENKOV COUNTER.

atti, G.Giacomelli, W.A.Love, W.C.Middelkoop and T.Yamagata.
sci. Instrum. (USA), Vol. 32, No. 8, 949-52 (Aug., 1961).

A Cherenkov counter for use as a γ-ray and electron spectrometer in the 1-10 GeV region is described. The calibration of the counter with monoenergetic electrons shows its response to be linear at least up to 14 GeV. The pulse-height spread improves with increasing energy and it is better than 10% (full width at half-height) for energies above 5 GeV.

13229 γ SPECTOGRAPHY USING CRYSTALLINE DIFFRACTION. M.Frilley.

C. R. Acad. Sci. (France), Vol. 253, No. 1, 100-2 (July 3, 1961).
In French.

The advantages of crystalline diffraction for γ-ray spectrography are discussed. R.H.Thomas

13230 PULSE RISE TIME FOR CHARGED PARTICLES IN p-n JUNCTIONS.

H.M.Mann, J.W.Haslett and G.P.Lietz.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 151-6 (Jan., 1961).
[Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Measurements of rise time for alpha particles of energy 6 MeV were made using a system with a rise time of 7.5 nsec. Surface barrier and diffused junction detectors show a dependence of rise time (t) upon reverse bias (V) of the form $t \propto V^{-x}$ where $0.4 \leq x \leq 0.9$. The rise time was determined by the lifetime of minority carriers or by base resistivity. The results show no limitation in application of these detectors to 10 nsec coincidence resolving times, since the depletion layer can be extended to reduce the effective RC time constant of the detector below 10 nsec. There are two tables and five figures. W.Bardsley

13231 TRANSIENT RESPONSE OF p—n JUNCTION DETECTORS. C.T.Raymo and J.W.Mayer.

IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 157-61 (Jan., 1961).
[Proceedings of the Seventh National Meeting. Solid State Radiation Detectors].

The object of the work was to determine the factors influencing the rise and decay of the transient voltage response of the junction detector to individual nuclear particles. The factors governing the voltage rise and decay times are discussed; namely, the charge collection time, the equivalent circuit of the detector, and the characteristics of the amplifier and display system. Experimental data on silicon p—n junctions is presented in nine figures. It is concluded that further information on the carrier velocity in the space-charge region and on the influence of dielectric properties in this region is required. W.Bardsley

13232 A SIMPLE LOW BACKGROUND PHOTON COINCIDENCE DETECTOR FOR TRITIUM LIQUID SCINTILLATION COUNTING. R.S.Sigmond and K.G.Schjetne.

Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 93-101 (1961).

The electronic system of this coincidence counter consists of two 13-stage Venetian blind photomultipliers coupled to a simple DeBenedetti—Richings coincidence circuit, followed by a medium-gain amplifier, pulse selector and scaler. The main feature of the system is its simplicity, chiefly realized by utilizing the quasi-linear transfer properties of the take-the-lesser type coincidence circuit. "Balance-point operation" permits the use of multiplier high voltage supplies and pulse amplifiers not possessing the high stability usually required for scintillation counting. The counter was operated at 26° C with a tritium counting efficiency of 16% at a background of 100 c/min. The minimum detectable tritium concentration in water is 1.7×10^{-8} curie/litre. However, the time needed for the counter to "quite down" after a change of sample is prohibitively long, 2-3 days. Of the background, nearly 50% seems to be caused by light interaction between the photomultipliers. Some suggestions for future improvements are given.

13233 MEASUREMENT OF ABSORBED DOSE OF NEUTRONS AND OF MIXTURES OF NEUTRONS AND GAMMA RAYS.

Handb. Nat. Bur. Stand. (USA), No. 75, 86 pp.(1961).

This handbook provides a summary of the available methods of determining energy absorption in matter by its interaction with neutrons. Because neutrons are almost always accompanied by γ-radiation, mixtures of γ-radiation and neutrons are included. Sections deal with: the units of radiation dosimetry; methods of dosimetry, including calorimetry, ionization and chemical methods and spectral measurements; instruments and methods for determination of dose; and applications to radiobiology and radiation protection. Calculations of first collision doses versus both photon energy and neutron energy are discussed in appendices. An extensive bibliography is given. C.F.Barnaby

13234 THE SELECTIVE MEASUREMENT OF NEUTRON AND PHOTON DOSES WITH AN ETHYLENE DOSIMETER.
F.P.Pott and S.Wagner.
Nukleonik (Germany), Vol. 2, No. 7, 271-6 (Dec., 1960). In German.

Dose measurements of fast neutrons from a Ra(α) Be source with an ethylene—polyethylene proportional counter yielded a result $\sim 6\%$ lower than that expected theoretically. This is attributed to experimental and theoretical uncertainties, e.g. in the knowledge of the neutron spectrum. It was shown that neutron and photon doses can be selectively measured in mixed radiation fields, if, in the second case, the same counter is used as an ionization chamber with gas multiplication, the ratio of the photon doses in ethylene and air being constant in the energy region 150 keV-5 MeV. The conversion of these doses into the biologically important tissue dose is discussed, and a method of measuring the charge per α-pulse is described. I.C.Demetsopoullos

13235 THE EFFICIENCY TRACING TECHNIQUE FOR ELIMINATING SELF-ABSORPTION ERRORS IN $4\pi\beta$-COUNTING. P.J.Campion, J.G.V.Taylor and J.S.Merritt; appendix by J.M.Kennedy.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 1, 8-19 (May, 1960).

This paper examines in detail the validity of a standardization technique recently described by Merritt et al. in which the advantages of the $4\pi\beta-\gamma$ coincidence method in eliminating self-absorption errors are extended to pure β-emitters by the addition of suitable $\beta-\gamma$ "tracer" nuclides. Calculations based on several models for the self-absorption process together with further experimental results supporting the method are presented and compared. The use of these theoretical considerations in making corrections for complex disintegration schemes in coincidence counting is discussed. The application of this "tracer" technique to nuclides having complex disintegration schemes is demonstrated for Rb^{86} and the result used to obtain a value of $8.7 \pm 0.2\%$ for the fraction of disintegrations populating the 1.08 MeV level in Sr^{86}.

13236 A UNIVERSAL FUNCTION FOR COMPUTING COUNTING PERFORMANCE. M.A.Greenfield and R.L.Koontz.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 205-10 (Oct., 1960).

Formulae are developed for evaluating the statistical accuracy of systems that measure radioactivity, and a universal counting performance curve is given. Examples are given of problem solving.

13237 CONTINUOUS ROTATION SCATTERING CHAMBER OF NEW DESIGN. J.Verba and R.Hawrylak.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1037-9 (Sept., 1961).

A scattering chamber, consisting of a fixed cylinder upon which a cylindrical sleeve slides in helical motion, has been designed and constructed. This chamber allows continuous rotation under vacuum over an angular range from -5° to + 165°. With a moderate increase in dimensions it would be practical to extend the angular range to ± 175°.

Track Visualization

13238 LOW PRESSURE EXPANSION CLOUD CHAMBER. V.S.Ajdačić, M.A.Cerineo, Z.D.Dimitrijević and A.A.Milojević.
Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 33-42 (March, 1960).

A pressure-defined expansion cloud chamber, operating at final pressure of 2-3 mm Hg, was constructed. Satisfactory results were obtained by cooling the entire chamber, thus lowering the saturation pressure of different vapours used. However, better results were attained using nonsaturated vapour without the cooling system. The best track conditions for different initial pressures were investigated and determined by changing the ratio of the partial pressures of unsaturated vapours and permanent gas. The experimental results are analysed and discussed.

13239 A LOW PRESSURE EXPANSION CLOUD CHAMBER. M. Rama Rao.
Indian J. Phys., Vol. 35, No. 2, 92-100 (Feb., 1961).

A pressure-defined expansion cloud chamber was constructed and operated satisfactorily up to total pressures of 5 cm of Hg. The best track conditions for different total pressures as a function of the expansion ratio were determined using ethyl, n-butyl anc iso-amyl alcohols as condensant vapour and argon as permaner gas. Photographs are presented of α tracks from Po^{210} taken a 5 cm of Hg with an iso-amyl alcohol and argon mixture.

13240 A METHOD OF INVESTIGATING COMPLEX NUCL REACTIONS. A.V.Kulikov, V.P.Chizhov and I.P.Y
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 77-80 (Jan. 1, 1961). In Russian.

A fast cycling cloud chamber is operated in association wi three counter telescopes which allow simultaneous measureme of both energy and energy loss of heavily ionizing particles generated in nuclear interactions occurring in the cloud chamb A short description is given of the chamber and of the electro which, while controlling the duty cycle, allow the signal from t counter telescope to be displayed on an oscilloscope. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 6 (July, 1961)]. G.Ma

13241 THE REALISATION OF A SELF-TRIGGERING, VARIABLE PRESSURE WILSON CLOUD CHAMBE OF A NEW TYPE. II. T.Yuasa, G.Corbe and F.Reide.
J. Phys. Radium (France), Vol. 21, Suppl. No. 7, 123 A-128 A (July, 1960). In French.

For Pt I see Abstr. 3894 of 1960. A description of the elec system of self-triggering and some characteristic data of the chamber, which operates at very low pressures, are given.

13242 DIFFUSION CLOUD CHAMBERS FOR USE WITH ELECTRON SYNCHROTRONS OF 1100 MeV AT FRASCATI AND OF 100 MeV AT TURIN.
P.E.Argan, A.Gigli, E.Picasso, V.Bisi, G.Piragino, G.Bendisc and A.Piazzoli.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 2, 215-40 (1960). In

Describes the construction and the operation characteristi two large high pressure diffusion cloud chambers, one of which operated in a magnetic field with a maximum value of about 18 recently constructed by the Genoa Section of the I.N.F.N. The scientific programme for the future is covered briefly and incl the utilization of the 1100 MeV synchrotron at Frascati and the 100 MeV synchrotron at Turin. The auxiliary apparatus for th chambers, the methods for exposing them, together with the s for analysis of the photographic records, are outlined.

13243 THREE LITERS LIQUID HYDROGEN BUBBLE CHAMBER.
P.Bassi, R.Cano, S.Focardi, G.G.A.Michelini and F.Saporetti.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 184-91 (1960).

The bubble chamber is described in detail. The total cons tion of liquid hydrogen is 1.1 litre/h; distorsions are negligible

13244 CHARACTERISTICS OF LIQUIDS FOR USE IN A BUBBLE CHAMBER. R.Kato.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 30-6 (1961).

The sensitive regions of several liquids in a continuously sensitive bubble chamber were determined. These sensitive r are discussed on the saturated vapour pressure versus temper curves of the liquids which were used in the chamber. An easi operated expansion chamber was also constructed, which work low pressure by reducing the pressure in the liquid from a pre expansion pressure of one atmosphere. Some qualitative chara istics of it are given.

13245 IMPROVED CONTINUOUSLY SENSITIVE BUBBLE CHAMBER. R.Kato.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 926-7 (Aug., 1961).

In order to increase the sensitive volume and the sensitiv time, the geometrical size and the heating system of the cham are improved. By using an organic liquid and carbon dioxide solution as the liquid in the chamber, the apparatus is made sensitive to fast-neutron irradiation.

13246 ON THE PHOTOGRAPHIC AND INSTRUMENTAL STUDY OF THE TRANSVERSE DIMENSIONS OF I TRACKS IN NUCLEAR EMULSIONS. C.Gégauff.
Ann. Phys. (France), Vol. 5, No. 7-8, 1027-84 (July-Aug., 1960 In French.

The study of the theoretical and practical problems assoc with the identification of a multiply charged ion in nuclear emu from measurements on the profile of the track is presented. I shown that there exists some dependence of the width of the tra on the method of measurement; in particular it would appear t the filar micrometer is not sufficiently objective. The effect o development of the emulsion on the profile is stressed; howev roved possible to discriminate between tritons and cles by recourse to physical development of the emulsion. er of experimental results were obtained indicating that the on of a track by a multiply charged ion proceeds by a two- echanism. It is found that Ilford G 5 emulsion is most suited imination between particles with $Z < 7$. For $Z \geq 7$ Ilford L 4 emulsions give comparable results. For the identifi- of ions with charge between 6 and 18, simple gap counting ction of the residual range can be used in emulsions with sensitivity such as Ilford K 0, K 1 or K 2.

S.J.St-Lorant

7 THE INFLUENCE OF NITRIC ACID ON THE SENSITIVITY OF NUCLEAR EMULSIONS TO α PARTICLES,
THE ERADICATION OF THE TRACKS. R.Chasset.

d. Sci. (France), Vol. 252, No. 25, 3976-8 (June 19, 1961). ch.

ha irradiated pellicles of nuclear emulsion soaked in dilute cid and washed with alcohol show a decrease in sensitivity the exposure takes place within 15 min. following the . It may be assumed that in a pellicle impregnated with m dissolved in nitric acid, the α particles will not produce cks until after the plate is removed from the bath.

S.J.St-Lorant

8 AN ESTIMATE OF LOSSES DURING THE FORMATION OF A LATENT PHOTOGRAPHIC IMAGE BY IONIZING
CLES. A.L.Kartuzhanskii.

rdogo Tela (USSR), Sbornik [Supplement] II, 296-300 (1959). ian.

ionizing particle passing through an emulsion crystal es a high instantaneous density of conduction electrons. hor considers the losses of these electrons due to recom- with halogens and the failure of some silver atoms (pro- y neutralization of Ag+ by electrons) to take part in the mage formation.

A.Tybulewicz

9 A STUDY OF DEVELOPMENT DEFECTS AND TRACK STRUCTURES IN NUCLEAR EMULSIONS USING AMIDOL
OPERS. O.N.Kaul.

. Phys., Vol. 35, No. 4, 183-92 (April, 1961).

velopment defects and the dependence of track and grain res on the various development parameters were investigated. d formulae are suggested for the removal of microscopic fog, ion defects, and also for the background eradication. The res used differ from the ones adopted by other authors results, although identical in most cases, differ slightly in respects.

0 METHOD AND FORMULA OF FIXING FOR THICK NUCLEAR PLATES ELIMINATING THE CORROSION OF
GRAINS. H.Braun.

. Radium, (France), Vol. 21, Suppl. No. 7, 73A-78A 960). In French.

e corrosion of the silver grains in thick nuclear plates may to several causes such as the composition, the pH, the silver l, the redox potential and the volume of the fixing bath. vere investigated. The author proposes a method of fixing and la for the fixing bath containing ascorbic acid, which makes ble to obtain thick nuclear plates free of corrosion and y transparent.

51 SPURIOUS SCATTERING AND THE PROCESSING OF NUCLEAR EMULSIONS.
ond, C.Patou and M.Scherer.

. Radium (France), Vol. 22, Suppl. No. 2, 30A-34A (Feb., In French.

tudy was made of the influence of processing nuclear ns on spurious scattering, particularly the effects of drying, in a solution of glycerine and the temperature of develop-

52 DENSITY vs. EXPOSURE CURVES OF A PHOTOGRAPHIC EMULSION FOR 20 ~ 200 kV ELECTRONS.
gi, N.Kitamura and S.Morimoto.

. Soc. Japan, Vol. 16, No. 4, 792-3 (April, 1961).

nsity (D)—Exposure (E) curves measured for Fuji Process romatic plates for electrons with energy 20 ~ 200 kV are Dependence of developing conditions on D—E curves was amined. At a suitable developing condition, D—E curves for ns with higher energy than 50 kV are linear over a wide f density, and for electrons with lower energy they bend lower density.

13253 MAXIMUM LIKELIHOOD DETERMINATION OF THE SCATTERING CONSTANT OF AN EMULSION TRACK IN THE PRESENCE OF NOISE.
L.Jánossy and P.Rózsa.

Nuovo Cimento (Italy), Vol. 20, No. 5, 817-35 (June 1, 1961).

Formulae are deduced for the determination of two parameters of an emulsion track with help of the maximum likelihood method. The parameters are the constant of the Coulomb scattering and the amplitude of background noise. Numerical expressions are obtained for the scatter of the measured values of these constants and it is shown, e.g. that in case of very fine subdivision of a track the statistical error of the constants thus obtained decreases proportionally to $N^{-\frac{1}{3}}$, where N is the number of sections. Formulae are obtained which are useful for the practical determination of the parameters and which give accuracies only slightly smaller than that obtained by the optimal maximum likelihood method. Graphs are provided to facilitate numerical computations.

13254 REMARKS UPON THE DENSITOMETRY OF THE TRACKS OF HEAVY NUCLEI IN NUCLEAR EMULSION.
D.Evans and R.R.Hillier.

Nuovo Cimento (Italy), Vol. 20, No. 5, 936-48 (June 1, 1961).

An analysis of the structure of tracks of heavy nuclei in nuclear emulsion leads to a method whereby charge scales appropriate to any given parameter which has arisen through measurement upon a track by means of a densitometer may be calculated. As an example, the mean widths of tapers at a residual range of 100 μm are calculated for various values of the charge and good agreement with experimental results is obtained.

13255 PRECISION DEPTH MEASUREMENTS IN NUCLEAR EMULSIONS.
D.Heughebaert and J.Heughebaert.

Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 147-52 (1960). In French.

A simple auxiliary instrument is described which permits the measurement of depth of successive grains in a track while maintaining the objective in a fixed position. The accuracy achieved is of the order of 0.1 μ over a track length of some 20 μ. The net gain in precision obtained with this method was evaluated for Ilford G5, K5 and L4 emulsions. The instrument is essentially the same as the one described earlier (Abstr. 12477 of 1960).

S.J.St-Lorant

13256 THE DEVELOPMENT OF NUCLEAR EMULSION STACKS.
A.Garin, M.Lévi and H.Faraggi.

Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 240-4 (1960). In French.

Shows that it is possible to obtain satisfactory development of Ilford K5 emulsions using only four reagents, namely amidol, sodium sulphite, citric acid and sodium thiosulphate. In the course of the different operations the pH of the baths is maintained approximately constant between 6 and 6.8.

S.J.St-Lorant

13257 INVESTIGATIONS ON A HYPERSENSITIZED ILFORD EMULSION.
E.Dahl-Jensen.

Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 245-50 (1960).

Ilford have recently produced a new experimental nuclear emulsion of very high sensitivity — it is of the K-5 type but, having been hypersensitized, has a sensitivity which is nearly doubled with respect to the ordinary K-5 emulsion. In this note, the keeping qualities of the exposed plates are described together with some discussion of the variation of the sensitivity from surface to glass. Finally, the relationship between the development time in an amidol developer and the corresponding sensitivity are described.

13258 A DEVICE FOR DIP-ANGLE MEASUREMENT OF TRACKS IN NUCLEAR EMULSIONS.
B.Antolković.

Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1-3 (1961).

The device is an additional part of the microscope but does not require the modification of the microscope itself.

13259 DISCRIMINATION OF TRACKS OF PHOTOFISSION FRAGMENTS WITH VERY HIGH BACKGROUND OF ALPHA-PARTICLES AND ELECTRONS IN NUCLEAR EMULSIONS.
H.G. de Carvalho and A.G. da Silva.

Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 24-9 (1961).

With common chemicals used in photography such as amidol, boric acid, sodium sulphite and potassium bromide, a developing bath was prepared which permits a complete discrimination of the tracks of highly ionizing particles, such as fission fragments, in the presence of strong background radiation such as that produced by the electrons from a 2000 röntgen X-ray dose and a background of 10^{11} α-particles/cm^3.

13260 A REMARK ON THE DETECTION OF EVENTS IN NUCLEAR EMULSIONS. C.J.Waddington.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 37-40 (1961).

It is shown that the frequently used method of "rescanning" to determine the efficiency with which events have been detected in the course of a systematic search, may, under certain conditions, lead to seriously misleading conclusions.

13261 MEASUREMENT OF ANGLES IN NUCLEAR INTERACTIONS OF FAST PARTICLES. V.M.Chudakov.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 37-8 (Nov.-Dec.).
In Russian.

The possible methods of analysing the angles of emission of shower particles produced in photographic emulsions by high-energy interactions are surveyed and a new one proposed. This is based on the determination of the coordinates of the points of intersection of the tracks with a sphere centred at the origin of the shower. [English translation in: Instrum. Exper. Tech. (USA), No. 6, 896-8 (Nov.-Dec., 1959; publ. Sept., 1960)]. R.E.Meads

13262 A NEW METHOD OF DETERMINING THE PARAMETER OF MULTIPLE COULOMB SCATTERING.
Z.Al'per and É.Fridlender.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 39-41 (Nov.-Dec.).
In Russian.

A simplified method of obtaining the parameter of multiple Coulomb scattering from photographic plate data is described, to which automatic methods can conveniently be applied. Instead of finding the arithmetic mean of scattering sagittas, the total number N of these, together with the number N* exceeding a certain value δ* are measured. It is shown that the required parameter can be obtained from these results. [English translation in: Instrum. exper. Tech. (USA), No. 6. 899-901 (Nov.-Dec., 1959; publ. Sept., 1960)]. R.E.Meads

13263 A DEVICE FOR THE IDENTIFICATION OF MULTIPLY-CHARGED PARTICLES STOPPING IN NUCLEAR EMULSIONS. A.P.Zhdanov and I.M.Kuks.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 45-7 (Jan.-Feb.)
In Russian.

Describes a photoelectric attachment for a microscope, which can be used to measure the width of short tracks in emulsions, e.g. lithium hammer-tracks. S.Chomet

MEASUREMENT OF THERMAL NEUTRON FLUX WITH EMULSIONS IN GEL FORM. See Abstr. 13451

13264 PROPERTIES OF A SPARK CHAMBER.
E.F.Beall, B.Cork, P.G.Murphy and W.A.Wenzel.
Nuovo Cimento (Italy), Vol. 20, No. 3, 502-8 (May 1, 1961).

A spark chamber was constructed of seven aluminum plates, each $\frac{1}{2}$ in. thick and separated by a $\frac{1}{4}$ in. gap. Using this device permits the trajectory of a charged particle to be observed by detecting the light produced by a spark discharge between the plates when a high-voltage pulse is applied to alternate plates. The efficiency of this chamber was measured for high-energy charged particles produced at the Bevatron. When the chamber is filled with 1 atm. of neon or argon, the efficiency per gap is greater than 99% if a $\frac{1}{4}$ μsec of pulse greater than 10 kV for neon or 15 kV for argon is applied to the plates within $\frac{1}{3}$ μsec after the charged particle traverses the gap between the plates. Multiple tracks, such as those produced by a nuclear reaction in the plates can easily be photographed. The recovery time of the chamber, after a spark discharge between the plates, is approximately 10 msec. The sensitive time is of the order of 10 μsec unless a clearing field is applied to one set of the plates. With a clearing field of approximately 160 V/cm, the sensitive time is reduced to less than $\frac{1}{2}$ μsec. When the chamber had 4×10^5 particles incident on it in 0.1 sec, three tracks per trigger were sometimes observed, in agreement with the measured sensitive time. The chamber also functioned with a magnetic field of 13 kG parallel to the plates. The tracks were displaced by an amount proportional to the magnetic field. In addition, if a high clearing field, E, was applied and if a long time was allowed to elapse before the high-voltage pulse was applied, the sparks in alternate gaps were displaced in opposite directions by an amount proportional to E × B. Both the momentum and the time of traversal, relative to the time of applied voltage, could be determined in this manner.

13265 CONTROLLED SPARK CHAMBER — A NEW DEVI FOR THE OBSERVATION OF CHARGED PARTICL TRACKS. V.A.Mikhailov, V.N.Roinishvili and G.E.Chikovani.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 39-42 (Jan.-Feb.)
In Russian.

The device consists of a set of parallel brass plates mount a glass container. The latter is filled with neon at 1.1 atm. A (10^{-7} sec) high-voltage pulse is applied to the plates immediate after the passage of a charged particle. This gives rise to a localized streamer discharge, roughly along the line of flight of the particle. Typical values used are: gap length 1 cm, plate t ness (brass) 1-2 mm, voltage pulse delay 1 μsec, field between plates 10 kV/cm. S.Ch

13266 PARALLEL PLATE COUNTERS WITH ELECTRON CALLY CONTROLLED TRIGGERING FOR THE DETERMINATION OF PARTICLE TRAJECTORIES. J.Trümp
Atomkernenergie (Germany), Vol. 5, No. 4, 121-8 (April, 1960)
In German.

A telescope consisting of parallel plate counters for detern the trajectories of high energy particles in cosmic rays is desc The counters operate just below the static breakdown voltage ar the case of a coincidence are triggered by a high voltage impuls The sparks are recorded photographically. In this way the life is larger than that of those counters which always operate in th spark region, and a bigger surface area of the counter can be u The telescope may be triggered by a G.M. coincidence. The er in determining the position of the particle in the counter is 0.2 The efficiency for weakly ionizing particles is 96%. A counter h a scattering layer of 0.04 g/cm^2 Al.

NUCLEAR FIELD THEORY

13267 LECTURES ON SELECTED CHAPTERS OF QUANT FIELD THEORY. G.Heber.
Abhandl. Deutschen Akad. Wiss. Berlin, Kl. Math. Phys. Tech. (Germany), 1960, No. 8, 58 pp. In German.

An introductory but critical survey is given of modern developments in quantum field theory up to March, 1960. Only attempts that go beyond the conventional local field theories ar cussed. The following topics are covered: older attempts to a ultraviolet divergences; Lehmann—Källén theorem; indefinite m in Hilbert space and the Lee model; methods for elimination of "ghost states"; the Van Hove—Ruijgrok model; Heisenberg's no linear spinor equation and attempts to do without field equation conventional sense. F.H

13268 ON THE BETHE—SALPETER METHOD IN THE THIRRING MODEL. K.Ladányi.
Acta phys. Hungar., Vol. 12, No. 3, 199-204 (1960).

The Bethe—Salpeter equation of the time-ordered two-part amplitude in the Thirring model (Abstr. 2758 of 1958) is solved ladder approximation. It is shown that the correct antisymmet solution appreciably differs from the amplitude derived by Scar (Abstr. 1083 of 1959).

13269 GENERAL THEORY AND NUMERICAL TABLES O CLEBSCH—GORDAN COEFFICIENTS. T.Shimpuk
Suppl. Progr. theor. Phys. (Japan), No. 13, 1-135 (1960).

For convenience in evaluating the Clebsch—Gordan coeffic the new general expressions are derived starting from Cartan' theory of spinor representation, and several special formulae a given, in particular, algebraic tables for $j' = 7/2-5$. In additio numerical tables for $j' = 1/2-6$ and $j = 5, 11/2, 6$ are provided.

13270 EXACT TREATMENT OF THE BOUND STATE PROBLEMS IN THE NON-RELATIVISTIC QUANTU FIELD THEORY. N.Mugibayashi.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 803-21 (May, 1961)

An exact equation for the bound state of nucleons in the sta neutral scalar model is obtained by using the field equation for Heisenberg operator and the method of canonical transformatio The formulation of the eigenvalue problem is completed by the analyticity consideration. In particular, a boundary condition a $\tau = 0$ ($-i\tau$ being the "negative imaginary" relative time) turns o that the derivative of the "wave function" with respect to τ mus be zero at $\tau = 0$. Abnormal solutions exist in this case as well in the ladder approximation, but there is a difference in nature en them for the zero meson mass case. The appearance of mal solutions is mainly due to the structure of the fundal equation itself. This is demonstrated by handling a first equation for the static neutral scalar model and the Bethe—ter equation for the Lee model, in both cases of which mal solutions do not appear.

271 SOLUTION OF THE EQUATIONS FOR THE GREEN'S FUNCTIONS OF A TWO DIMENSIONAL RELATIVISTIC D THEORY. K.Johnson.
o Cimento (Italy), Vol. 20, No. 4, 773-90 (May 16, 1961).

The explicit solution of the coupled set of equations for the n's functions for the self-coupled field theory model of Thirring ven. It is found that the infrared problem causes no special ulty. The question of how to define products of singular field ators at coincident space-time points arises and it is shown he commutation relations for such products are not consistently by making use of the formal expressions and the canonical nutation relations. The problem of gauge invariance in an nal field is studied and it is shown that: (a) the current and ge density do not commute at equal times, and (b) this is ssary for and consistent with the gauge invariance of the field tions.

3272 THE ANALYTICITY DOMAIN OF THE FOUR-POINT FUNCTION. G.Källén.
ear Phys. (Internat.), Vol. 25, No. 4, 568-603 (June, 1961).

A characterization of the boundary curves determining the yticity domain of the four-point function is given. The paper s only with the analyticity domain that follows when local commuta- y of the field operators is not invoked. The domain is found bounded by obvious generalizations of the surfaces one has for hree-point function and by an entirely new surface which is not nalytic hypersurface. The equation of the new surface is stigated in some detail and its properties are illustrated with erical plots.

13273 THE STRUCTURE OF MOMENTUM SPACE, THE NEUTRINO AND THE PAULI PRINCIPLE. H.Fröhlich.
ear Phys. (Internat.), Vol. 26, No. 2, 324-37 (Aug., 1961).

Although right and left-handedness cannot be defined geometric-, the distinction between the two concepts can be so defined. m this observation it is concluded that the quantity in terms of h this distinction is made should be introduced as an explicit ure in the mathematical treatment of space. Application of this to null vectors in momentum space leads to an equation which nally is identical with the wave equation of the two-component rino field theory together with the reflected equation. Moreover, n the requirement of invariance of covariant quadratic express- under phase transformation, it follows with necessity not only the field must be quantized but also that this must be done rding to the Pauli principle. A complete geometrical interpreta- of the neutrino is thus obtained. The neutrino charge in ticular is found to be given in terms of the newly introduced rdinate which describes the distinction between right- and left- dedness.

13274 HIGH ENERGY LIMIT OF VERTEX FUNCTION IN QUANTUM FIELD THEORY. S.Aramaki.
gr. theor. Phys. (Japan), Vol. 24, No. 1, 210-11 (July, 1960).

The high energy behaviour is studied under assumptions more eral than those of Lehmann, Symanzik and Zimmermann (Abstr. 1 of 1955). P.K.Kabir

3275 CAUSALITY AND LOCAL COMMUTATIVITY. K.Yamamoto.
gr. theor. Phys. (Japan), Vol. 24, No. 3, 684-5 (Sept., 1960).

Argues, from an example, that a certain "macroscopic sality" condition (Abstr. 3140 of 1961) is stronger than local mutativity. R.J.N.Phillips

3276 QUANTUM MECHANICAL SYSTEMS WITH INDEFINITE METRIC. I. E.C.G.Sudarshan.
s. Rev. (USA), Vol. 123, No. 6, 2183-93 (Sept. 15, 1961).

The structure of quantum theories with indefinite metric is died with the aid of several simple models. It is shown that the udounitary scattering matrices entering such a theory are not onsistent with physical interpretation provided a suitable ariant projection of physical state is carried out from among the states. A relativistic quantum theory of interacting fields is lined and is guggested as a basis for a dynamical theory of mentary particles. It is argued that the formal introduction of an indefinite metric together with supplementary interpretive postulates may help to reinstate the principle of simplicity in a consistent theory of elementary particles.

13277 QUANTUM MECHANICAL SYSTEMS WITH INDEFINITE METRIC. II. H.J.Schnitzer and E.C.G.Sudarshan.
Phys. Rev. (USA), Vol. 123, No. 6, 2193, (Sept. 15, 1961).

Several simple models, similar to that of Lee, involving indefinite metric are studied in this paper. In this connection, a dispersion-theoretic treatment is applied to a simple "equal-mass" model. It is shown that, at least for these models, the scattering amplitude is analytic in the upper-half energy plane provided time-reversal invariance holds; the rules of the dispersion-theoretic formulation in the case of an indefinite metric theory are given. The solution is reinterpreted as the exact solution of a slightly different model which can also be obtained by Hamiltonian techniques; further techniques are generalized to include recoil in a relativistic no-pair model. Certain basic questions of interpretation are discussed in some detail in the concluding section.

13278 INDEFINITE METRIC IN QUANTUM FIELD THEORY. K.L.Nagy.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 1, 92-131 (1960).

In this comprehensive review article, the author outlines the reasons for quantizing certain theories with an indefinite metric, the methods of doing this, the associated problems and some of their solutions. The gravest difficulties generally are in connection with the probabilistic interpretation, and with certain exceptions, namely, quantum electrodynamics and theories with a ghost type of pole, they have not been overcome. C.Wilkin

13279 ON THE RENORMALIZATION EFFECTS IN THE THRESHOLD BEHAVIOUR OF THE PERTURBATION EXPANSION TERM OF THE TWO-POINT GREEN FUNCTION IN QUANTIZED FIELD THEORY. S.Dembiński.
Acta. Phys. Polon. (Poland), Vol. 20, No. 8, 663-74 (1961).

Gives the perturbation expansion of the Lehman's spectral function in powers of the renormalized coupling constant in the three scalar field model. It is shown that some of the branch points in the perturbation term of the two-point Green function, due to Landau—Polkinghorne conditions, are excluded if the internal lines renormalization is realized.

13280 CAUSALITY CONDITION AND NON-LOCAL LAGRANGIAN IN QUANTUM ELECTRODYNAMICS. V.A.Shcherbina.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 93-5 (May 1, 1961). In Russian.

Causality requires that Lagrangians commute for two points x, x' when $(x - x')^2 < 0$. By expressing Langrangians in terms of generalized Schwartz functions (whose transforms determine the momenta and wave-number) the consequences of the causality condition are investigated for solutions of the Klein—Gordan equation. The limitations imposed on the solutions are listed. [English translation in: Soviet Physics—Doklady (USA)] J.W.Gardner

13281 THE SUPPLEMENTARY CONDITION IN QUANTUM ELECTRODYNAMICS. C.A.Hurst.
Nuovo Cimento (Italy), Vol. 21, No. 2, 274-93 (July 16, 1961).

A presentation of the supplementary condition in quantum electrodynamics is given which is free from normalization difficulties even with a definite metric. The supplementary condition is treated as a generator of a commutative sub-algebra in the ring of field operators. This sub-algebra generates an ideal in its own commutator algebra, and the corresponding remainder ring is the set of all physical gauge invariant operators. Any representation of this remainder ring is free from normalization difficulties. The relationship of this approach to that of Fermi, Candlin and Gupta is discussed.

13282 A POSSIBLE ESTIMATE OF THE ELEMENTARY LENGTH IN ELECTROMAGNETIC INTERACTIONS. J. Kvasnica.
Czech. J. Phys., Vol. 10, No. 9, 625-7 (1960).

The difference of 0.2 Mc/s between the theoretical and experimental values of the Lamb shift of the hydrogen terms $2s_{1/2}$ and $2p_{1/2}$ is used to estimate the elementary length λ in an electromagnetic interaction. The calculated difference of the hydrogen terms in the Bopp—Podolsky potential field

$$\varphi(r) = \frac{e}{4\pi r}\left(1 - e^{-r/\lambda}\right)$$

is compared with the given difference $\Delta \cong 0.2$ Mc/s. From this the elementary length $\lambda \cong 0.1 \times 10^{-13}$ cm is obtained. The distribution of the electric charge in the proton

$$\rho(r) = \frac{e}{4\pi\lambda^2} \frac{e^{-r/\lambda}}{r}$$

leads to the Bopp—Podolsky potential if the Coulomb interaction is assumed to be valid in the whole space.

13283 APPLICATION OF THE FOLDY—WOUTHUYSEN TRANSFORMATION TO SEVERAL CASES OF ELECTRON INTERACTION WITH AN ELECTROMAGNETIC FIELD.

M.Baktavatsalou.

J. Phys. Radium (France), Vol. 22, No. 3, 159-64 (March, 1961).
In French.

A general expression of the fourth approximation $(1/m)^4$ for the Dirac Hamiltonian, without odd matrices, is given using the Foldy—Wouthuysen method. The interaction is then discussed in the following three cases: (a) static magnetic field; (b) static electric field; (c) electromagnetic field varying with time and satisfying the Maxwell—Lorentz equations. The physical interpretation of the different terms obtained from the final result is also discussed.

13284 QUANTUM STATISTICAL ANALOGUE OF WARD'S IDENTITY. K.Watanabe, O.Kamei and H.Ezawa.

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 735-42 (May, 1961).

Considering quantum statistical electrodynamics, an identity is proved which corresponds to Ward's in quantum electrodynamics. In the course of the discussion, an emphasis is put on the periodicity properties of the functions which appear therein.

A STUDY OF THE GENERATORS OF HIGH ENERGY SOFT SHOWERS AS A POSSIBLE CHECK ON THE LAWS OF QUANTUM ELECTRODYNAMICS. See Abstr. 13551

13285 NON-LINEAR EQUATIONS FOR SPINOR FIELDS. J.Rayski.

Acta phys. Polon. (Poland), Vol. 19, No. 3, 409-11 (1960).

A plausible form of nonlinear spinor equations, similar to Heisenberg's equation is derived by analogy with general relativity.
R.F.Peierls

13286 TENSOR AND SPINOR FORMALISM INCLUDING PARITY. J.Winogradzki.

J. Phys. Radium (France), Vol. 21, No. 12, 835-45 (Dec., 1960).
In French.

Exposition of a formalism based on the systematical use of the eight second rank spinors the components of which are invariant under the transformations of the full Lorentz group The great simplification brought out by this formalism, in particular for the calculation of the parities, is shown by the solution of some typical problems about spinor forms. Using the eight second rank spinors with invariant components as operators, one forms from every first rank spinor, ψ, four spinors of the same variance as ψ and four spinors contragradient to ψ. As example of application of the new formalism to the study of a spinor field, these eight spinors are examined when ψ is the Dirac field. Study of the first class shows the analogy between the sign changes of the charge and of the mass and gives the relative parities of any two conjugated fields. Knowledge of the second class allows the construction of new lagrangians.

13287 SPINOR FIELD AND ITS TRANSFORMATIONS. Z.Tokuoka.

Suppl. Progr. theor. Phys. (Japan), No. 13, 137-99 (1960).

A reformulation of the Dirac theory of the electron, which is another representation of Gürsey's wave matrix formalism, is given. By using this formalism, the isomorphisms of various transformations of a spinor are explicitly proved. In the first part the reformulation is developed on its own. This formalism is the reformulation of the Dirac theory corresponding to Case's reformulation of the Majorana theory. A means of describing the (V, A) Fermi interactions is given. In the second part the general theory of wave matrix is derived without referring to the special representations. Gürsey's wave matrix formalism is derived from the above formulation by the transformation of representation. The connection between Gürsey's formalism and the Dirac theory is made clearer. In the last part various transformations of a four-spinor are investigated, and the isomorphisms among some of them are proved. These transformations are not always canonical, and the conditions that they become canonical are investigated.

13288 PROPAGATORS WITH DIPOLE GHOSTS FOR FERM
FIELDS. K.L.Nagy.

Acta phys. Hungar., Vol. 13, No. 1, 21-4 (1961).

The spectral representation of propagators for relativistic
fermion fields has been calculated in field theories, where the
existence of dipole ghost states with $p_0 \geq 0$ are assumed. This
general result is compared with a form obtained by Mitter (Abs
17248 of 1960) in a certain approximation for a Heisenberg
(Abstr. 2134 of 1958) type of theory.

13289 ON A GENERALIZED FOLDY—WOUTHUYSEN TRA
FORMATION. C.G.Bollini and J.J.Giambiagi.

Nuovo Cimento (Italy), Vol. 21, No. 1, 107-18 (July 1, 1961).

A correspondence between the Lorentz and the Foldy—
Wouthuysen transformation is discussed. It is extended to any
Lorentz transformation and it is shown that the transformation
fined by Cini—Toushek fits as a special case of this correspond
It is shown that while the Lorentz transformation operates in a
space with an indefinite Lorentz invariant metric, the Foldy tra
formation here discussed operates in a space with a positive de
euclidean metric. This correspondence is extended to any spin.
particular discussion is given for the spin 1 case, for which a
Hamiltonian equation is proposed.

13290 ON A GENERALIZATION OF THE FOLDY—WOUTHUYSEN TRANSFORMATION TO PARTICLE
OF ANY SPIN WITH NO EXTERNAL FIELD AND SOME APPLICATIONS. M.Baktavatsalou.

C.R. Acad. Sci. (France), Vol. 252, No. 19, 2824-6 (May 8, 1961
In French.

The general Foldy—Wouthuysen transformation for a partic
of any spin is obtained from elementary transformations corres-
ponding to particles of spin $\frac{1}{2}$. It is applied to the Hamiltonian a
to the position operator. The latter result is compared with the
one of Newton—Wigner.
F.H

13291 ON SOME PROBLEMS OF THE S-MATRIX FORMA
FOR UNSTABLE PARTICLES. J.Werle.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), V
No. 3, 207-10 (1961).

In treating interactions involving unstable particles by an
S-matrix theory, the energy spreads and finite lifetimes are si
neglected. The author shows how this mass spread can be intr
into the S-matrix formalism and hence how some of the inconsi
encies of the older treatments can be removed. The process
$\Sigma^- \rightarrow n + \pi^-$ is investigated in detail.
C.W

13292 MASS SPECTRUM DEDUCED FROM AN EQUATION
PROPAGATION CONTAINING PARTIAL DERIVAT
OF INFINITE ORDER. M.Zăgànescu.

C.R. Acad. Sci. (France), Vol. 252, No. 21, 3198-200 (May 24, 1
In French.

A general propagation equation is formulated of which the
Yukawa equation is a particular case; it demonstrates that a m
spectrum arises in a natural way.
J.H.

13293 ON A NONRELATIVISTIC WAVE EQUATION FOR SPIN-1 PARTICLES. J.Penné.

C.R. Acad. Sci. (France), Vol. 252, No. 26, 4126-8 (June 26, 19
In French.

Derives a wave equation for a particle with internal struct
and angular momentum.
R.J.N.Phi

13294 CONSTRUCTION OF A COVARIANT DENSITY MATRIX IN THE THEORY OF THE SPIN $\frac{1}{2}$ PARTIC
M.Broise.

Cahiers de Phys. (France), Vol. 15, 199-209 (May, 1961).
In French.

The statistical operators of nonrelativistic quantum mecha
are generalized and a hermitian density matrix is defined, by m
of which the densities of mean values can be obtained. The cov
ant density matrix is then defined as the covariant matrix which
equal to the hermitian density matrix in the frame of reference
which the particle is at rest.
F.H

13295 THE FUSION OF TWO PARTICLES IN FUNCTIONA
THEORY. F.Aeschlimann.

J. Phys. Radium (France), Vol. 21, No. 12, 859-62 (Dec., 1960).
In French.

Study of a system of two particles with spin in relativistic
functional theory; of the equation of the barycentric wave, of the

tions of the relative motion and of the reduced equation. In the ɔus states of the system, in some cases the relative waves :onstants. This corresponds to vanishing relative motion. In :ase of two particles of spin 1/2 of the same mass, a melted em is obtained which is equivalent to a particle with spin 1. n this result, by the approximation giving the usual wave mech- s, the equations given by the fusion method are obtained. The ɔn method is thus justified and its physical significance is rent.

3296 PARTICLE FUSION IN FUNCTIONAL THEORY.
J.L.Destouches.
nys. Radium (France), Vol. 22, No. 1, 27-34 (Jan., 1961).
rench.

The barycentric wave of a part of a physical system and relative ɛs are studied in relativistic functional theory. (A "melted" part of a em is defined: a part is melted if the relative waves of its icles are constant). Evolution-equation and condition-equations he u_p wave of a melted part P are given. Particular cases are :usion of 2 and 3 particles and fusion of the whole system. :essive fusions and the proof of equivalence with only one fusion studied; particular cases: particles with spin $\frac{3}{2}$ and particles spin 2 obtained by direct fusion of 3 and 4 particles of spin $\frac{1}{2}$ y successive fusions. Several fusions are equivalent to only one ɔn. Nuclear phenomena with the creation and annihilation or ısformation of particles can be described by fusion processes.

3297 PROPERTIES OF FUSED SYSTEMS IN THE FUNCTIONAL THEORY [OF PARTICLES]. J.L.Destouches.
hys. Radium (France), Vol. 22, No. 2, 76-82 (Feb., 1961).
'rench.

Several transformations of the fundamental equations for a ɛd part of a physical system. The nature of the values of the m_j fficients of the particles in a fusion process is discussed. The perties of distinguishable waves and of linear phase waves in a ɛd part of a system are considered. The necessary and sufficient dition for the fusion of two particles is given. The waves of a npletely fused state and of a fused particle are defined. The form he non-linear terms in a fused part of a system, and the properties of the mean wave of an assembly of fused systems are cussed. A wave is suggested from which may be deduced the ic linear equations assumed by the linear de Broglie theory of on. The properties of the mean wave are determined by measment and the linear de Broglie equations deduced.

3298 GRAVITON—ELECTRON INTERACTION IN FUNCTIONAL THEORY. Pham Xuan Yen.
Phys. Radium (France), Vol. 22, No. 3, 165-8 (March, 1961).
French.

Expressed by the coupling terms in the equations of these two ticles. The action of the electron in the gravitational equations is resented in terms of its energy-momentum tensor. Conversely, potential of the gravitational field associated with the graviton cts on the motion of the electron.

3299 INTRINSIC SYMMETRY PROPERTIES COMPARED WITH INVERSION GROUPS IN PARTICLE THEORY,
D THE RELATION BETWEEN SPIN AND STATISTICS. K.H.Tzou.
Phys. Radium (France), Vol. 22, No. 3, 142-8 (March, 1961).
French.

Deals with some intrinsic symmetry properties of certain rix operators in connection with each of the inversion operations. h the aid of these intrinsic properties, it is shown that either the unitary—unitary inversions or the unitary—antiunitary ones can ermine the statistics of elementary particles from their spin, if postulate the invariance of the field quantization rules in any one hese operations. The unitary—unitary inversions or the antiary—antiunitary ones, however, will not give particle statistics. s particularly remarked that the CPTM invariance, like the CPT ariance, is not automatic in the quantum theory of fields; they are / reliable in this case when the elementary particles obey the istics corresponding to their spin.

3300 A THEORY FOR LEPTONS.
K.H.Tzou.
Phys. Radium (France), Vol. 22, No. 5, 257-66 (May, 1961).
French.

A single model is proposed for the electron and muon, in which two leptons form an M-doublet. The theory is based on the ımetrization of the mass term in the equation of a spinor field, that has also a certain self-coupling. This spinor field has two different rest-mass states, identified with the electron and muon. The four-component neutrino is a special case in this M-doublet model. The non-conservation of parity in the weak interaction is a consequence of the M-symmetry principle. The fundamental leptonic weak current is of the type V only and is thus exactly similar to the electron-muon electric current. The neutrinos coupled to the electron and muon in the weak current are two particles of opposite helicity which are the two members of a four-component neutrino. The existence of solutions of the fundamental field equation in monochromatic plane waves is proved. The theory gives rise to no modifications in the classic results and conclusions of the usual electron theory in atomic physics. A possible generalization of the M-doublet model to baryons and mesons is also discussed.

13301 THEORY OF LEPTONS. I.
E.C.G.Sudarshan.
Nuovo Cimento (Italy), Vol. 21, No. 1, 7-28 (July 1, 1961).

A finite relativistic theory of four-fermion interactions is formulated; the theory involves as an essential ingredient the use of an indefinite metric. The problems of interpretation raised by the use of the indefinite metric are analysed in relation to the observables and structure of many-particle states in quantum field theory; and the consistency of the interpretive postulate is demonstrated. The theory incidentally provides a "raison d'etre" for the muon.

13302 A REMARK ON THE STRANGENESS AND ISOTOPIC SPIN FOR LEPTONS.
T.Okabayashi, S.Nakamura and Y.Nisiyama.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 701-12 (April, 1961).

The problem is examined of whether the strangeness and isotopic spin assignment for leptons proposed by Gamba et al. (Abstr. 10593 of 1959) and Klein (Abstr. 5604 of 1960) fits the leptonic weak interactions to the same extent as in the case of the weak interactions between baryons and mesons. It is shown that there should exist two kinds of neutral massless lepton (ordinary and strange neutrino) in order to accept the selection rule $|\Delta S| = 1$. Then all the observed weak interactions satisfy this rule, but the strangeness-assignment allows some strangeness-conserving leptonic processes such as $K^0 \rightarrow \mu^+ + e^-$ and $K^+ \rightarrow \mu^+ + e^- + \pi^+$. Further, there are some undesirable processes in which strangeness changes by one unit, for instance, $\mu^+ \rightarrow 2e^+ + e^-$ and $\mu^- + p \rightarrow p + e^-$. At the present status of experiments, it is impossible to get any definite conclusion about the isotopic spin selection rule. It is however shown that, except for $\mu \rightarrow e + \nu + \bar{\nu}$, $\mu^- + p \rightarrow n + \nu$ and probably $\pi \rightarrow \mu + \nu$, the selection rule $|\Delta I| = \frac{1}{2}$ may be regarded to hold in fairly good approximation, if restriction is made to interactions in which the strangeness change is ±1. The significance of the existence of these important exceptional cases is discussed.

13303 NOTE ON THE $\Delta I = \frac{1}{2}$ SELECTION RULE IN THE COMPOSITE MODEL OF ELEMENTARY PARTICLES.
S.Okubo and R.E.Marshak.
Nuovo Cimento (Italy), Vol. 20, No. 4, 791-6 (May 16, 1961).

The Salam—Ward hypothesis concerning the $\Delta I = \frac{1}{2}$ selection rule in weak interactions is examined from the viewpoint of the composite model of elementary particles. In this theory, the non-leptonic weak decays have a different origin than the leptonic decays and are attributed to a small perturbation on the strong interactions.

13304 THE ERIKSEN TRANSFORMATION IN THE CASE OF PARTICLES WITH SPIN 0 AND 1. H.Høgaasen.
Nuovo Cimento (Italy), Vol. 21, No. 1, 69-75 (July 1, 1961).

It is shown how the Eriksen transformation (Abstr. 2071 of 1959) can be used in the reduced Kemmer theory, and how this simplifies scattering and spin precession of the vector particle.

13305 NEUTRAL SCALAR σ-MESON AND THE MASS DIFFERENCE BETWEEN MUON AND ELECTRON.
K.Tanaka.
Nuovo Cimento (Italy), Vol. 21, No. 1, 169-76 (July 1, 1961).

The self-mass arising from the interaction of a leptonic field with a scalar neutral σ-meson is calculated in perturbation theory to examine the possibility that the electron may be regarded as a light muon because the sign of the self-mass is negative. Further, the consequences of a model in which a leptonic field interacting with the σ-meson can describe the electron and muon as eigenstates are studied.

13306 FUNCTIONAL METHODS FOR COMPOSITE PARTICLES. G.C.Wraith.

Nuovo Cimento (Italy), Vol. 21, No. 2, 352-60 (July 16, 1961).

The aim of this paper is to show how Symmanzik's functional formalism can be extended to the case of many fields of arbitrary spin, which may form composite particles of arbitrary spin and mass spectra. It is shown that this can be done whether or not interpolating fields exist for the composite particles, and that the S-matrix is the same in either case.

13307 NOTE ON THE PION PROPAGATOR IN THE COMPOSITE THEORY. T.Kanki.

Progr. theor. Phys. (Japan), Vol. 25, No. 1, 156-8 (Jan., 1961).

The author calculates a pion propagator by iterating the $N-\bar{N}$ bubble. The effect, compared with the lowest order, is appreciable even for small separations of the two nucleons. J.E.Paton

13308 STRANGE NEUTRINO AND A COMPOSITE MODEL FOR ELEMENTARY PARTICLE. I.

T.Ouchi and K.Senba.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 684-700 (April, 1961).

A composite model of the elementary particles is proposed by taking the stable particles, proton, electron, neutrino and strange neutrino (ν'), as the basic particles. The strange neutrino is introduced by mass reversal theory as the β-decay product of the Λ-particle. It differs from the usual neutrino by mass parity and carries a unit of strangeness. The two neutrinos are both left-handed two-component Dirac spinors. This model greatly simplifies the mechanism of interactions because the basic particles are limited to the stable ones. It is noted that the charge-independent strong interactions uniquely require a "vacuum-cloud" which is always attached to the core of the elementary particle. The important role of the vacuum-cloud is discussed. The interactions observed are empirically classified by the three independent reactions inside the core as follows: (a) The origin of the strong interactions is the reaction $P \rightleftharpoons \pi^0 P$, where π^0 is the symbol for the state $P\bar{P}$; (b) the reactions responsible for the leptonic decays of baryons are only $\mu\nu \rightleftharpoons e\nu$ and $\mu\nu' \rightleftharpoons e\nu'$, and (c) the non-leptonic decays of baryons take place through the strangeness nonconserving reaction, $\nu' \rightleftharpoons \pi^0\nu$. The complete selection rules for the leptonic events are established. In this model the event $\Sigma^+ \rightarrow N + e^+ + \nu'$ is possible, while Sakata's model (Abstr. 6884 of 1957) forbids this. The existence of a new neutral pion $\pi^{0'}$ belonging to $I = 0$ is suggested.

13309 ON THE "NAGOYA MODEL" OF THE ELEMENTARY PARTICLES. N.S.Kalitzin.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 719-20 (April, 1961).

The author points out that he has previously suggested a model (Abstr, 9944-5 of 1959) whose basic idea is almost identical with the "Nagoya model". (Abstr. 3120 of 1961). C.Wilkin

13310 INTERNAL DEGREES OF FREEDOM AND ELEMENTARY PARTICLES. I. T.Takabayasi.

Progr. theor. Phys. (Japan), Vol. 25, No. 6, 901-38 (June, 1961).

The quantum theory of point-like systems is established by extending the concept of the relativistic particle in some respects: A point-like system means a one-parameter series of events $x_\mu(\tau)$ with substantial internal degrees of freedom concentrated upon x_μ, and an indefinite metric in Hilbert space is generally taken as to the internal degrees. The theory corresponds to an extention of the usual local field equations, suitable to obtaining a unified theory of elementary particles. The rest-mass, $m^2 = -p_\mu^2$ (with p_μ as momentum—energy vector) becomes a dynamical quantity of the system with its possible eigenspectrum, leading to uncertainty relations between rest mass value and space—time localization. The internal angular momentum tensor $S_{\mu\nu}$ is another basic dynamical quantity of the system and is responsible for spin and zitterbewegung. Also defined is the instantaneous velocity operator v_μ, which is not generally colinear with p_μ and must be restricted by certain kinematical conditions. Three different criteria about these conditions on v_μ make point-like systems classified into various types. For "normal class" of systems, $\rho \equiv -v_\mu^2$ is an absolute invariant with eigenvalue 1 or 0 and is regarded to represent the baryon number. Especially important are point-like systems of the first kind, i.e. the ones in which v_μ commute with the position x_μ and thus mean internal variables. Such a system generally has, besides rest mass, spin and ρ, three self-adjoint commuting invariant quantities formed
out of p_μ, v_μ and $S_{\mu\nu}$ only, which are to be identified eventual
with the intrinsic properties of elementary particles (isospin
hyper-charge, etc.). Systems are further divided into "class
models", where velocity components are commutable (an exa
being the relativistic rotator), and "non-classical models" wh
they are not ($[v_\mu, v_\nu] \neq 0$), in order to derive general charac
for each of them. Dirac and Kemmer particles are special s
examples of the latter, where the system has no substantial i
degrees of freedom apart from v_μ.

13311 INVARIANCE GROUP ASSOCIATED WITH RELA IC ROTATORS AND BILOCAL THEORY.

F.Halbwachs, J.M.Souriau and J.P.Vigier.

J. Phys. Radium (France), Vol. 22, No. 7, 393-406 (July, 1961

In French.

Three noteworthy results are established. First, it is sh
that in the frame of a very general treatment, the set of funda
constants of the motion which can be derived from each invari
group of a given line-Lagrangian gives rise to classical Poiss
brackets which fulfil relations identical to the Lie algebraic r
lations of the group. Secondly, any particle endowed with inte
variables can be represented by a "bilocal" rotator composed
two relativistic tetrads localized at two different points. Fina
the usual one-parameter and two-parameter gauge transforma
in spinor form can be translated into tetrad form with an obvi
kinematical interpretation.

13312 REMARKS ON THE VISCOUS DISSIPATION IN RELATIVISTIC HYDRODYNAMICS. M.Hamaguch

Progr. theor. Phys. (Japan), Vol. 24, No. 4, 908-9 (Oct., 1960)

An estimate is made of the order of magnitude of the visc
terms in the energy—momentum tensor in the author's hydrod
mical model of elementary particles. It is concluded that
reasonable results could be expected even if the viscous coeff
were treated as constant parameters. R.A.N

13313 POSSIBLE TRANSFORMATIONS OF REAL MASSL SCALAR WAVE EQUATION OF SECOND ORDER.

Vachaspati and M.Jauhari.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 2, 115-28 (March 26

The co-ordinate transformations under which the real sca
massless wave equation $\Box^2\psi = 0$ is invariant are examined. It
shown in an elementary straightforward way that among contin
transformations the equation admits only the 15-parameter rel
vistic conformal group of transformations and no others. The
infinitesimal and finite forms of the acceleration transformati
are discussed at some length. In general, the new co-ordinate
$x^{\mu'}$, are determined by the equations

$$\Box^2(\alpha x^{\mu'}) = 0,\ \Box^2(\alpha x^{\mu'}\, x^{\nu'}) = 2\beta g^{\mu\nu},\ \text{and}\ \Box^2\alpha = 0,$$

where α and β are two arbitrary functions of x^μ satisfying thes
equations. A possible singular solution of these equations is

$$\alpha = D^{(1)}(x),\ \alpha x^{\mu'} = \frac{\partial D^{(1)}}{\partial x_\mu}.$$

However, other possibilities are not ruled out. See also follow
two abstracts.

13314 INVARIANCE OF WAVE EQUATIONS OF MASSLES PARTICLES OF SPIN HALF. I. FOUR COMPON EQUATION. Vachaspati.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 254-62 (May 26, 1

Invariance of the massless Dirac equation under continuou
coordinate transformations is examined. The widest group un
which the equation is invariant is shown to be the relativistic
conformal group. Explicit expressions for the transformed wa
function and equations are given. The extent to which the char
conjugate solution may mix is determined.

13315 INVARIANCE OF WAVE EQUATIONS OF MASSLES PARTICLES OF SPIN HALF. II. TWO COMPONE EQUATION. Vachaspati.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 326-34 (May 26, 1

Invariance of the two-component neutrino equation under
continuous coordinate transformations is examined. The wides
group under which the equation is invariant is shown to be the
relativistic conformal group. Explicit expressions for the tra
formed wave function and equation are given. It is shown that,

st to the four-component case, the wave-function and its
ex conjugate cannot mix.

16 ON THE APPLICATION OF THE METHODS OF SUPERCONDUCTIVITY THEORY TO THE PROBLEM IE MASSES OF ELEMENTARY PARTICLES.

'aks and A.I.Larkin.
:sper. teor. Fiz. (USSR), Vol. 40, No. 1, 282-5 (Jan., 1961).
:sian.

pplied to a Heisenberg-type four-fermion two-component
ngian with cut-off. Owing to the rearrangement of the vacuum
the two-component nature of the initial field does not hinder
pearance of a fermion mass. Boson excitations are found
are analogous to acoustic excitations in a superconductor.
.ction between the excitations is discussed. [English trans-
in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 192-3
1961)].

317 WEAK INTERACTIONS.

[Interazione deboli].
conti della Scuola Internazionale di Fisica "Enrico Fermi",
) XI. Bologna: Zanichelli (1960) 406 pp.

'or abstracts of the papers presented at the above summer
l see Abstr. 8050, 8420-1, 8429, 8444, 8446-7, 8469, 8473,
8497, 8499, 8636, 8646 of 1961.

318 THE GLOBAL SYMMETRY IN WEAK INTERACTIONS.

J.Lukierski.
Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8,
1-12, 803-6 (1960).

ırgues that a possible invariance of weak interactions under
imultaneous interchanges $\Lambda \leftrightarrow \mu^-$, $n \leftrightarrow e^-$, $p \leftrightarrow \nu$ (see Abstr.
of 1959) and $\Lambda \leftrightarrow e^-$, $n \leftrightarrow \mu^-$, $p \leftrightarrow \nu$, can be explained by the
ept of a universal "neutrino charge". R.J.N.Phillips

319 EVALUATION OF THE PHASE SPACE INTEGRAL IN THE STATISTICAL TREATMENT OF MULTIPLE PRO- TION WITH ANGULAR MOMENTUM CONSERVATION.

:zka.
Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9,
, 85-91 (1961).

hows how to calculate this integral in the nonrelativistic and
me-relativistic approximations. R.J.N.Phillips

320 A MODEL OF LEPTONS AND OF WEAK INTERACTIONS.

Kuo-Hsien Tzou.
rs de Phys. (France), Vol. 15, 171-82 (April, 1961). In French.

ı unified model for the electron and the muon is proposed in
they form a doublet with respect to mass inversion. The four-
onent-neutrino is a special case in this model. The non-
rvation of spatial parity in weak interaction is a consequence
symmetry with respect to mass inversion. The possibility of
ding the model to baryons and mesons is studied. The quanti-
on rules of the field of a mass-symmetry-doublet are estab-
l and the parity of the lepton doublet, of the proton and of
in baryons which take part in weak interactions are defined.
ly the conservation of the doublet parity and the corresponding
tion rule in electromagnetic and weak interaction are shortly
ssed. F.Herbut

321 ON THE WEAK INTERACTION OF BARYONS.

S.Nakamura.
ys. Soc. Japan, Vol. 15, No. 8, 1543-4 (Aug., 1960).

ı symmetry operator, S, is introduced which reverses the
ric charge of particles without turning them into antiparticles.
invariance under S together with chirality invariance are
sed on the weak interaction Hamiltonian,certain experimental
ts on decays are explained and various predictions are made
ture experiments. R.F.Peierls

322 ON THE $\mu \rightarrow 3e$ DECAY AS A TEST OF THE APPLICABILITY OF THE PERTURBATION EXPANSION IN THEORY OF WEAK INTERACTIONS. J.Nilsson.

o Cimento (Italy), Vol. 21, No. 1, 135-44 (July 1, 1961).

As a test of the applicability of the perturbation expansion in
heory of weak interactions the $\mu \rightarrow 3e$ decay is considered. The
interactions are given in the usual current × current form
ding quadratic terms like $(\bar{e}\nu)(\bar{\nu}e)$. The best value so far
able for the branching ratio $\mu \rightarrow 3e/\mu \rightarrow e + \nu + \bar{\nu}$ then requires
-off at 90 GeV to make the theoretical predictions compatible with the experimental findings. This cut-off is in agreement with the cut-off obtained in $\mu \rightarrow e + \gamma$ decay discussed earlier by Ioffe.

13323 BROKEN SYMMETRIES AND BARE COUPLING CONSTANTS. M.Gell-Mann and F.Zachariasen.

Phys. Rev. (USA), Vol. 123, No. 3, 1065-71 (Aug. 1, 1961).

There are known cases of symmetry laws valid for one kind of interaction but broken by another. Each symmetry is then supposed to be exact for bare masses and coupling constants but only approximate for the renormalized quantities, like neutron and proton masses. The authors ask how the equality of unrenormalized constants can be rephrased as a statement about measurable quantities. This question is particularly important in connection with proposed strong-interaction symmetries that are supposed to be badly broken. The answer appears to involve the limits of ratios of experimental quantities at very high momenta. The authors discuss first the connection between wave-function renormalizations and weak and electromagnetic form factors. Then the authors take up the measurement of strong-interaction vertex renormalization factors by the study of scattering amplitudes at energies and momentum transfers large compared to all masses. The last part of the work is based in part on indications from the perturbation development of pseudoscalar meson theory, but it is hoped that it will point the way to similar results in a better theory.

13324 SYMMETRY IN SAKATA'S MODEL AND WEAK INTERACTIONS. II. M.Ikeda, Y.Miyachi and S.Ogawa.

Progr. theor. Phys. (Japan), Vol. 25, No. 1, 121-52 (Jan., 1961).

In Pt I (Abstr. 10845 of 1961) a scheme was proposed for non-leptonic decays of hyperons and K-mesons in the full symmetry theory of Sakata's composite model. In this paper the decay scheme is further investigated. First it is shown that the relations between various decay amplitudes are independent of particular configurations assigned to the particles which participate in the reactions. Then the K—3π decay is studied, showing that the decay scheme is quite successful. Finally, anomalous decay modes in which there appear one or more $\pi^{0'}$ or $\pi^{0''}$ in place of π^0 are discussed.

13325 INTERACTIONS IN NUCLEON CORE.

S.Minami.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1006-16 (June, 1961).

It is pointed out that K—N interaction rather than π—N interaction plays the important role in the phenomena within nucleon core. The processes of pion—nucleon scattering through s-wave pion—pion interaction are classified into two parts, which are, the processes in the nucleon core and those in the neighbourhood of a pion cloud. The contributions from the former to pion—nucleon scattering are estimated and are compared with those from the processes through the mechanism via KK$\pi\pi$-interaction which may be regarded as one of the phenomena in nucleon core. Moreover, some discussion about the anomalous magnetic moments of nucleons is made.

13326 OBTAINING AN EFFECTIVE HAMILTONIAN FOR DIRECT ELECTRON—ELECTRON INTERACTION IN THE ADIABATIC APPROXIMATION.

S.S.Stel'makh and Yu.V.Tsekhmistrenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 6, 806-8 (1959). In Ukrainian.

13327 DERIVATION OF STRONG INTERACTIONS FROM A GAUGE INVARIANCE. Y.Ne'eman.

Nuclear Phys. (Internat.), Vol. 26, No. 2, 222-9 (Aug., 1961).

A representation for the baryons and bosons is suggested, based on the Lie algebra of the three-dimensional traceless matrices. This makes it possible to generate the strong interactions from a gauge invariance principle, involving eight vector bosons. Some connections with the electromagnetic and weak interactions are further discussed. See also following abstract.

13328 YUKAWA TERMS IN THE UNITARY GAUGE THEORY.

Y.Ne'eman.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 230-2 (Aug., 1961).

In recent work (see for example preceding abstract) the strong interactions were derived from a three-dimensional unitary gauge. Though the symmetries implied seem to fit most experimental facts, all versions lack Yukawa terms, i.e. no single pions or kaons are emitted or absorbed. Considering higher order graphs, it is shown here that Yukawa terms appear in the unitary gauge theory under certain CP assumptions.

13329 DIFFRACTION SCATTERING OF ELEMENTARY PARTICLES. P.T.Matthews and A.Salam.
Nuovo Cimento (Italy), Vol. 21, No. 1, 126-34 (July 1, 1961).

The diffraction scattering of elementary particles is discussed. It is pointed out that there is a possibility of charge exchange diffraction scattering, except when it is inhibited at very high energy by the Pomerančuk theorem (Abstr.8219 of 1958). The notion of inelastic diffraction scattering, recently discussed by Good and Walker (Abstr. 470 of 1961) is reformulated in relation to the field theory of unstable particles.

13330 SINGLE AND MULTIPLE SCATTERING OF CHARGED PARTICLES. E.Keil, E.Zeitler and W.Zinn.
Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1031-8 (Dec., 1960).
In German.

The angular distribution as a function of the number m of collisions between 0 and 20 was computed on an electronic machine. The results are tabulated and compared with those of Leisegang (Abstr. 7329 of 1951) for values of m up to 8 and, for m = 20, with the results of Molière's formula (Abstr. 609 of 1951).
W.A.Hepner

13331 APPLICATIONS OF CONFORMAL MAPPING TO THE PHENOMENOLOGICAL REPRESENTATION OF SCATTERING AMPLITUDES. W.R.Frazer.
Phys. Rev. (USA), Vol. 123, No. 6, 2180-2 (Sept. 15, 1961).

A series representation of scattering amplitudes analytic in cut planes is derived by means of a conformal mapping. The new series has the advantage that in general it converges more rapidly than the conventional power series. An example is considered in which an angular distribution which requires $(\cos\theta)^4$ terms for a good fit requires only second-order terms in the new series. The resulting advantages in using this series in extrapolations to poles are discussed. As a second example, a modified effective-range formula is derived.

13332 PIONIC GAUGE.
W.Królikowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 2, 105-6 (1961).

The author derives a pion mesodynamic analogy of electromagnetic gauge invariance by neglecting the primary pion—pion interaction.
C.Wilkin

13333 THE STRONG COUPLING AND THE RESONANCE PROBLEM IN THE MESON—NUCLEON REGION.
H.Jahn.
Nuclear Phys. (Internat.), Vol. 26, No. 3, 353-418 (Aug., 1961).
In German.

By means of a canonical and non-linear transformation of variables the original meson field is split into a free meson part and a self field part of the nucleon. The transformation is defined so that the interaction between the compound nucleon system thus arising and the free mesons vanishes in the case of infinitely strong coupling. It is shown that there exists a family of transformations satisfying the conditons. A system of equations for certain transformation functions is stated as the consequence of the conditions. The solutions of the field-splitting problem are investigated. The general scheme for a strong-coupling approximation method based on this field splitting is derived, and the problem of calculating the pion—nucleon resonance scattering from the strong coupling theory is treated on this basis. A special approximation is made for calculations near the resonance. Numerical results obtained from such a calculation are discussed. For the sake of simplicity the symmetric scalar fixed-source meson theory is used. But the principle of the method will be the same in the more essential but more complicated symmetric pseudoscalar case. Thus the present considerations will serve to guide an analogous investigation using the symmetric pseudoscalar theory.

13334 A POSSIBLE EXTENSION OF THE METHOD OF QUASI-REAL PROCESSES TO MESON THEORY.
P.Kessler and A.Jacquemin.
C.R. Acad. Sci. (France), Vol. 252, No. 19, 2830-2 (May 8, 1961).
In French.

This approximation method (Abstr. 20021 of 1960) is applied to processes in which a nucleon emits a pion, either the initial or final nucleon or the pion being virtual.
R.J.N.Phillips

13335 FOURTH ORDER SCATTERING MATRIX ELEME OF NUCLEONS WITH A FOURTH ORDER MESO EQUATION. S.P.Misra.
Indian J. Phys., Vol. 34, No. 5, 221-36 (May, 1960).

It is noted that the charge renormalization that is obtain this theory is finite and small for a reasonable value of the c constant. The contribution from the meson self-energy diagr remains unaltered and thus contains an infinity. A consistent interpretation of this term as meson mass renormalization i obtained only if the bare meson has two different rest-masse

13336 UNITARITY AND THE MANDELSTAM REPRESE ATION. II. R.W.Lardner.
Nuovo Cimento (Italy), Vol. 20, No. 4, 733-46 (May 16, 1961)

For Pt I, see Abstr. 5678 of 1961. An earlier investiga the analyticity of the three-particle unitarity contribution to scattering absorptive part is discussed more completely. Th general term is shown to reduce to the same form as the thr particle term.

13337 TWO-PARTICLE STRUCTURE OF THE MANDE REPRESENTATION. W.Zimmermann.
Nuovo Cimento (Italy), Vol. 21, No. 1, 36-58 (July 1, 1961).

The two-particle contributions to the Mandelstam repres tion of the scattering amplitude are separated for the three r channels simultaneously.

13338 REMARKS ON EDEN'S "PROOF" OF THE MANDELSTAM REPRESENTATION. N.Nakanish
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 155 (Jan., 1961).

The author claims to give a counter-example to the proof (Abstr. 5680 of 1961).
J.

13339 THE MANDELSTAM REPRESENTATION IN PER BATION THEORY FOR AN ANOMALOUS MASS RELATION. V.N.Gribov, M.V.Terent'ev and K.A.Ter-Marti
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 337-40 (Jan., 19
In Russian.

The analytic properties of the box diagram are investiga perturbation theory. With this diagram as an example, it is demonstrated how the Mandelstam representation must be mo in the case of an anomalous relation between the particle ma [English translation in: Soviet Physics - JETP (USA), Vol. 1 229-31 (July, 1961)].

13340 ON THE PHENOMENOLOGICAL ANALYSIS OF T S-MATRIX IN MULTIPLE PRODUCTION.
D.Ito, A.H.Zimerman, S.Ragusa and T.Miyazima.
Nuovo Cimento (Italy), Vol. 20, No. 5, 878-902 (June 1, 1961).

A method is proposed, based on the two-centre model, fo characterizing the S-matrix by relatively few parameters, wh are to be determined empirically.
R.J.N.

13341 INTERFERENCES AMONG FEYNMAN GRAPHS C DIFFERENT TOPOLOGY. E.R.Caianiello and K.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1038-41 (June 1, 1961).

In making approximations to fermion interaction process the question often arises as to whether the exclusion principl being correctly taken into account. Antisymmetrization of ini and final states alone, without regard to intermediate states, clearly not sufficient. However, antisymmetrization of Feynn graphs for all intermediate states in a given approximation d not automatically secure the exclusion principle. This is sho be because a given graph, or partial sum of graphs, although regarded for computation as a compact expression, is in fact of contributions arising from all the individual modes of the f fermion fields; these contributions may be cancelled by other belong, in the graphical representation, to diagrams which ar disregarded in the approximation chosen.
J.W.G

13342 THE RIEMANN SURFACE OF THE SCATTERING AMPLITUDE. Chan Hong-Mo.
Proc. Roy. Soc. A (GB), Vol. 260, 329-56 (May 16, 1961).

The first part of the paper bridges the gap between Khur and Peierls (1959). The Fredholm technique is used to study analytic properties of the scattering amplitude as a function c the energy and the momentum transfer for Schrödinger and K Gordon scattering from cut-off potentials and potentials with exponential and Yukawa tails. The discussion is extended to with several discrete channels. The second part deals with istic scattering of elementary particles. Conjectures rning the Riemann surface of the amplitude for the elastic ring of two identical particles and neglecting the production her particles are formulated. With the use of the Mandelstam ture (1958), it is found that the Riemann "surface" belonging scattering amplitude as an analytic function of the two ndent Mandelstam variables has at least eight "sheets". The y with potential scattering and perturbation theory suggests istence of further branch points on the "unphysical" sheets, would make the structure of the full Riemann "surface" very icated. Poles representing bound and metastable states on the ınn surface are discussed. The reality and unitarity conditions rmulated and their implications studied in connection with the lejo—Dalitz—Dyson ambiguity (1956).

343 ON THE UNIQUENESS OF A POTENTIAL FITTING A SCATTERING AMPLITUDE AT A GIVEN ENERGY.

rtin and G.Targonski.

Cimento (Italy), Vol. 20, No. 6, 1182-90 (June 16, 1961).

t is shown that when a scattering amplitude is known to be ıced by a superposition of Yukawa potentials, the exact know- of the scattering amplitude at a given energy determines in a e way the potential. This is established in two steps: (i) by ng that, once the physical scattering amplitude is known, the ntinuity across the cut in the complex plane of the momentum fer is uniquely defined; (ii) by establishing the rigorous connec- etween this discontinuity and the potential. In order to be by a superposition of Yukawa potentials at a given energy a ering amplitude has to satisfy certain conditions which are tigated. The treatment can be modified in order to include the of exchange forces.

3344 ANALYTIC BEHAVIOR OF THE SCATTERING AMPLITUDE AT ZERO ENERGY. W.Zimmermann.

o Cimento (Italy), Vol. 21, No. 2, 249-73 (July 16, 1961).

t is shown that the scattering amplitude has a two-sheeted h point at zero kinetic energy. The analytic continuation into econd sheet is discussed in detail.

3345 SINGULARITIES OF THE SCATTERING AMPLITUDE IN PERTURBATION THEORY.

Patashinskii, A.P.Rudik and V.V.Sudakov.

ksper. teor. Fiz. (USSR), Vol. 40, No. 1, 298-311 (Jan., 1961). ıssian.

The asymptotic behaviour of the position of the singularities of open envelope" perturbation-theory diagram is studied for one e invariants that tend to infinity. It is shown that in the ral case the "open envelope" has two singular curves. A od is developed for reducing the problem of determining the ılarities of any perturbation theory diagram with four external to the problem of the "open envelope" diagram with certain tive masses of virtual particles. Minorants are established he effective masses. The results are applied to a perturbation- retical analysis of $\pi\pi$, KK and NN scattering in the case when of the invariants that characterize the scattering amplitude s to infinity. It is found that under these conditions the $\pi\pi$ tering amplitude has no anomalous singularities in any urbation-theory approximation. Conditions are indicated under h the absence of anomalous singularities in the perturbation- ry diagram can be established in a number of cases for KK and scattering amplitudes. [English translation in: Soviet sics - JETP (USA), Vol. 13, No. 1, 201-10 (July, 1961)].

3346 ON THE SYMPLECTIC SYMMETRY.

A.Salam and J.C.Ward.

vo Cimento (Italy), Vol. 20, No. 6, 1228-30 (June 16, 1961).

The Salam—Polkinghorne theory (Abstr. 2653 of 1956) admits unitary symplectic group in 4-dimensions. There are ten ons and ten fermions corresponding to its representations, and vector mesons associated with it by gauge transformation.

J.E.Paton

13347 THE INVARIANT AMPLITUDES OF INTERACTION PROCESSES. A.C.Hearn.

vo Cimento (Italy), Vol. 21, No. 2, 333-45 (July 16, 1961).

A systematic method of producing, where possible, invariants a scattering process such that the associated amplitudes are from kinematical singularities is derived. It is conjectured such amplitudes cannot be found for most processes involving dd number of photons. The results are proved completely in perturbation theory, but a method of proof independent of perturbation theory is outlined. Invariants for the elastic scattering of pions and deuterons, and nucleon Compton scattering are derived as examples. General interaction processes are also discussed.

13348 ELEMENTARY DERIVATION OF THE MINAMI PHASE SHIFT AMBIGUITY. R.Van Wageningen.

Nuclear Phys. (Internat.), Vol. 26, No. 1, 126-8 (July, 1961).

An elementary derivation is presented of the Minami phase-shift ambiguity in the analysis of elastic scattering of a spin $\frac{1}{2}$ particle by a spin 0 scattering centre.

13349 A NON-LINEAR FIELD THEORY.

T.H.R.Skyrme.

Proc. Roy. Soc. A (GB), Vol. 260, 127-38 (Feb. 7, 1961).

A unified field theory of mesons and their particle sources is proposed and considered in its classical aspects. The theory has static solutions of a singular nature, but finite energy, characterized by spin directions; the number of such entities is a rigorously conserved constant of motion; they interact with an external meson field through a derivative-type coupling with the spins, akin to the formalism of strong-coupling meson theory. There is a conserved current identifiable with isobaric spin, and another that may be related to hypercharge. The postulates include one constant of the dimensions of length, and another that is conjectured necessarily to have the value $\hbar c$, or perhaps $\frac{1}{2}\hbar c$, in the quantized theory.

13350 PARTICLE STATES OF A QUANTIZED MESON FIELD.

T.H.R.Skyrme.

Proc. Roy. Soc. A (GB), Vol. 262, 237-45 (July 4, 1961).

A simple non-linear field theory is considered as the model for a recently proposed classical field theory of mesons and their particle sources (see preceding abstract). Quantization may be made according to canonical procedures; the problem is to show the existence of quantum states corresponding with the particle-like solutions of the classical field equations. A plausible way to do this is suggested.

13351 CHANGE OF VARIABLES IN QUANTUM FIELD THEORIES. J.S.R.Chisholm.

Nuclear Phys. (Internat.), Vol. 26, No. 3, 469-79 (Aug., 1961).

It is shown that any local or almost local change of variables in quantum field theories which leaves the free field part of the Lagrangian unchanged does not alter the S-matrix. The relation of this result to Haag's theorem (Abstr. 2044 of 1959) is discussed.

13352 THE ANALYTICITY PROPERTIES OF THE BETHE—SALPETER AMPLITUDE. K.Watanabe.

Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1373-6 (Dec., 1960).

The bound states of two bosons, interacting through a zero-mass boson field, are considered. The analytic properties of the normal and abnormal solutions of the Bethe—Salpeter equation, in the ladder approximation, are shown to be the same. Two of the poles which occur are absent in the exact Bethe—Salpeter amplitude.

I.J.R.Aitchison

13353 VALIDITY OF THE INTEGRAL REPRESENTATIONS FOR THE VERTEX PART IN PERTURBATION THEORY.

N.Nakanishi.

Progr. theor. Phys. (Japan), Vol. 25, No. 2, 296-7 (Feb., 1961).

Gives a proof that the integral representation of Deser, Gilbert and Sudarshan (Abstr. 13018 of 1959) is valid in every order of perturbation theory.

R.J.N.Phillips

13354 A NOTE ON PRODUCTION DISPERSION RELATION.

A.Minguzzi.

Nuovo Cimento (Italy), Vol. 20, No. 3, 599-600 (May 1, 1961).

In a previous paper (Abstr. 20076 of 1960), the author discussed problems concerning the dispersion relations for the production processes A + B → C + D, with special reference to the fact that the thresholds of the two processes A + B → A + B and C + D → C + D are in general different. It is now shown that the previous discussion on this point is unnecessary and that the question can be settled by the use of rotational invariance.

C.Wilkin

13355 ON THE EXISTENCE OF SOLUTIONS OF THE PION—PION DISPERSION EQUATIONS. I. C.Lovelace.

Nuovo Cimento (Italy), Vol. 21, No. 2, 305-15 (July 16, 1961).

It is proved that the Chew—Mandelstam equations for pion—pion scattering with both S and P waves possess no exact solutions, with the possible exception of solutions oscillating at infinity. The usual iteration procedures for solving these equations will be only asymptotically convergent in the low energy region, the convergence being worse the larger the P wave. A cut-off is therefore unavoidable. Since the expansion of the Chew—Mandelstam equations with S and P waves in powers of the coupling constant is known to be consistent in all finite orders, this is an example of a theory in which the exact solution behaves worse than any order of the perturbation expansion.

13356 DOUBLE DISPERSION REPRESENTATION OF VERTEX FUNCTION. K.Yamamoto.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 720-1 (April, 1961).

It is shown that, providing z is real and negative, the vertex function F satisfies the double dispersion relation

$$F(z_1, z_2, z_3) = \frac{1}{\pi^2}\int_{b^2}^{\infty} d\sigma_2^2 \int_{c^2}^{\infty} d\sigma_3^2 \, \frac{A_{23}(z_1, \sigma_2^2, \sigma_3^2)}{(\sigma_2^2 - z_2)(\sigma_3^2 - z_3)}$$

where z_1, z_2, z_3 are the mass variables corresponsing to the three external lines. C.Wilkin

13357 LOW-ENERGY LIMIT THEOREMS AND DISPERSION RELATIONS. K.Kawarabayashi.

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 780-96 (May, 1961).

Low-energy limit behaviour of various collision processes is re-investigated from the dispersion theoretic point of view, which turns out to be a powerful approach for obtaining low-energy limit theorems. Some low-energy limit theorems for the processes involving collisions of a boson with a fermion are obtained, using this method. It is shown that for pion—baryon scattering, certain isotopic spin combinations of the P-wave spin-flip amplitude is shown to be simply related to the renormalized pion—nucleon coupling constant, from which the magnitude of the coupling constant can be determined:

$$f^2/4\pi = 0.09 \pm 0.02 .$$

It is also shown that this determination is insensitive to the presence of (3, 3) resonance and a possible T = J = 1 pion—pion resonance.

13358 ON THE AXIAL VECTOR CURRENT CONSERVATION. Y.Katayama.

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 827-41 (May, 1961).

The conservation law of the axial vector in the β-decay is investigated in the pion—nucleon system interacting through ps(ps) and ps(pv) couplings together. The system necessarily contains other types of boson beside the pion-field in order to realize the conservation law in a limit of pion mass zero. Three new bosons, scalar (iso-scalar), vector (iso-vector) and pseudo-vector (iso-vector) bosons, are at least necessary. The meaning of their coexistence is discussed from the theory of composite model.

13359 CAUSAL DESCRIPTION OF THE POTENTIAL SCATTERING OF BARGMANN. J.Manuel Lozano.

Rev. Mexicana Fis., Vol. 9, No. 3, 149-61 (1960). In Spanish.

The form of the time-dependent Green's function for a potential of the Bargmann type is calculated explicitly. The relation between the time-dependent behaviour of the Green's function and the position of the poles and zeros of the S-matrix in the (complex) wave-number plane is discussed. I.J.R.Aitchison

13360 QUANTUM POTENTIALS (OF ELECTROMAGNETIC AND NUCLEAR FIELDS). T.C.Siokos.

Tech. Chron. (Greece), Vol. 37, No. 4, 347-56 (July-Aug., 1960).
In Greek.

A quantum-geometrical method is used to derive expressions for the quantum potential (defined as the four- and five-vector potentials developed to describe electromagnetic and nuclear fields, respectively) between two particles, in terms of their spins and isotopic spins. The theory attempts to explain the electrostatic force of attraction of repulsion (independent of the spin), p—n and p—p scattering phenomena, the saturation of nuclear forces, and the binding energies of H^2, He^4, He^5 and Be^8. See also following abstract. I.C.Demetsopoullos

13361 THE NUCLEAR BINDING ENERGY OF THE LIGHT ELEMENTS AND THE SATURATION OF NUCLEAR FORCES. T.C.Siokos.

Tech. Chron. (Greece), Vol. 37, No. 5, 417-23 (Sept.-Oct., 1960
In Greek.

Using the theory of quantum potential (see preceding abstra the binding energies of H^2, H^3, He^3 and He^4 are calculated and fo to be in agreement with existing experimental results. It is dec that for $A > 20$ the nuclear radius is independent of A, the numb of nucleons, and that the binding energy per nucleon is constant (8.56 MeV) thus explaining the saturation of nuclear forces. I.C.Demetsopo

13362 SOME PROPERTIES OF THE PROPAGATORS OF SCALAR FIELD INTERACTING WITH HIMSELF [ITSELF]. A.Visconti.

Nuovo Cimento (Italy), Vol. 20, No. 3, 596-8 (May 1, 1961).

Properties of the generating functional of the propagators derived. E.A.Sande

13363 EFFECT OF THE PARTICLE—HOLE PAIR INTER-ACTIONS IN NUCLEAR MANY-BODY PROBLEM. M.Yasuno.

Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1129-31 (Nov., 1960

It is shown that in the nuclear many-body system the effect particle—hole pairs transforms the short-range nuclear interac into a long-range one, in contrast with the screening effect of th Coulomb interaction in the many-electron case. A.M.G

ELEMENTARY PARTICLES

13364 INTRODUCTION TO ELEMENTARY PARTICLE PHYSICS. R.E.Marshak and E.C.G.Sudarshan.

New York, London: Interscience Publishers (1961) viii + 231 pp

The book is intended as an introduction to theoretical high energy physics for experimentalists or others of graduate level. Detailed dynamical calculations are avoided. Apart from the la section of the book, distinct fields are associated with the well established particles; the usual distinction is made between the strong, electromagnetic and weak interactions, and the only inva ance principles and selection rules considered are those on a firm experimental footing. There are five chapters under the following headings: (1) Introductory discussion; (2) Quantum-mechanical formalism in elementary particle physics; (3) Discr transformations and selection rules; (4) Additive conservation la (5) Isospin rotation and selection rules. Adequate author and subject indexes are provided.

13365 NEW STATES OF ELEMENTARY PARTICLES. S.Devons.

Sci. Progr. (GB), Vol. 49, 451-7 (July, 1961).

The modern interpretation of the concept of an elementary particle is discussed, and a description is given of some of the recently discovered "excited states" of the known elementary particles, and their properties. R.F.Pei

13366 SYMMETRIC COMPOSITE MODEL OF STRONGLY INTERACTING ELEMENTARY PARTICLES. Ya.B.Zel'dovich.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 319-23 (Jan., 1961
In Russian.

A scheme is considered in which all baryons $(p, n, \Lambda, \Sigma, \Xi)$ are composed of two particles and one antiparticle from a set of three elementary fermions A, B, C. It is shown that the best cho is that in which, as far as charge and strangeness are concerned A and B are identical to Ξ^0 and Ξ^- and C is identical with Λ. T masses of A, B, and C are assumed to be large so that these particles are unstable with respect to strong interactions and ar therefore unobservable. In this scheme the parity of all observa baryons is the same and opposite to the parity of the elementary fermions A, B, and C. Pions and K-mesons are pseudoscalar wi respect to the baryons. [English translation in: Soviet Physics JETP (USA), Vol. 13, No. 1, 216-19 (July, 1961)].

367 ON MASS FORMULA OF ELEMENTARY PARTICLES.
A.Ohmae.
Fac. Engng Hiroshima Univ. (Japan), Vol. 1, No. 4, 251-8
h, 1961).

mass formula is given in a form analogous to a line-
:um series. Using the formula the kaon-series, the sigma-
s, the nucleon-series, and the pion-series are derived. A
ınt corresponding to the Rydberg constant is determined.

368 STATISTICAL WEIGHTS IN MULTIPLE PARTICLE
PRODUCTION. J.Shapiro.
) Cimento Suppl. (Italy), Vol. 18, No. 1, 40-54 (1960).

ın analytic formula for the weights in a process of multiple
.ction in high-energy collisions is derived, valid for arbitrary
ers of particles in the final state, provided that they have
ɔic spins 0, $\frac{1}{2}$ or 1. Extensive tables are given for the second
r in the weights for those reactions which are experimentally
erest. F.Herbut

369 MASS DIFFERENCES OF CHARGED AND NEUTRAL
STATES OF ELEMENTARY PARTICLES. I.M.Freeman.
r. theor. Phys. (Japan), Vol. 24, No. 5, 1128-9 (Nov., 1960).

For all pairs of charged and neutral particles, the product
1 of the experimental mass M_0 of the neutral member, and the
lus ΔM of the difference in mass between the charged and
al members, is given, to within less than the experimental
in the masses, by the number $(2326)2^n$, where $n = 0,1,2,3,\ldots.$
lifference in mass of the Σ^+ and Σ^- lead to two values of
1 in this case, that found from Σ^- being much closer to the
ɔsed number. The author remarks that 2326 is very close to the
number of the Σ hyperons. I.J.R.Aitchison

370 ON AN ISOBARIC SPIN SCHEME FOR LEPTONS AND
THE LEPTONIC DECAYS OF STRANGE PARTICLES.
nakrishnan, A.P.Balachandran, N.R.Ranganathan and
Deshpande.
ar Phys. (Internat.), Vol. 26, No. 1, 52-6 (July, 1961).

n isobaric spin scheme for leptons is discussed using the
pt of missing components. A phenomenological set of rules
o suggested to explain the low rates of most of the
= 1 decays.

371 STATISTICAL THEORY OF MULTIPLE PARTICLE
PRODUCTION WITH ANGULAR MOMENTUM
ERVATION. Z.Koba.
phys. Polon. (Poland), Vol. 20, No. 3, 213-34 (1961).

A new formulation of the statistical theory of multiple particle
ıction is investigated in which the angular momentum of the
m is strictly conserved, and which can thus be applied to the
sis of peripheral collisions and the angular distribution of
ıdary particles. Fundamental formulae, simple examples, and
relevant remarks are presented.

otons

372 PRELIMINARY RESULTS ON THE PRODUCTION OF
MONOCHROMATIC PHOTONS BY THE ANNIHILATION
OSITRONS IN FLIGHT.
ler, C.Schuhl, G.Tamas and C.Tzara.
ys. Radium (France), Vol. 21, No. 5, 296-8 (May, 1960).
ench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble,
(see Abstr. 12029 of 1961). Studies efficiency of a process for
roduction of photons with a narrow spectrum and variable
y, based on the properties of the annihilation of positrons in
. The experimental results agree with calculation.

373 SOME EXPERIMENTS ON GAMMA-RAY BACK-
SCATTERING. T.Hyodo and S.Shimizu.
Inst. chem. Res. Kyoto Univ. (Japan), Vol. 39, No. 2, 180-8
ch, 1961).

The backscattered radiation was observed by a scintillation
rometer for Co^{60} and Cs^{137} gamma-ray point sources which
in contact with backscatterers of paraffin, aluminium, iron,
d lead. Contributions to backscattered rays from single and
e or multiple Compton scattering of incident gamma-rays
clarified. Intensity of backscattered radiation was measured as a function of scatterer's thickness. Although the experimental arrangement was not so simple that exact analysis of observed data could be performed, the experimental finding were interpreted qualitatively by theoretical predictions. The experimental results obtained may be useful in design considerations of experimental equipment using gamma-rays.

13374 CONTRIBUTION OF NEUTRAL PIONS TO PHOTON-PHOTON SCATTERING. M.Y.Han and S.Hatsukade.
Nuovo Cimento (Italy), Vol. 21, No. 1, 119-25 (July 1, 1961).

It is shown that the contribution of neutral pion intermediate states is as much important as electron—positron pair states for low energy photon—photon scattering. For unpolarized scattering the interference between two intermediate states is shown to vanish and the contribution of neutral pion states to the differential cross-section is shown to have a sharp maximum with 1.15×10^{-26} cm^2/sr at a total energy of photons corresponding to the pion mass. The forward and right-angle cross-sections for two intermediate states are compared.

13375 GAMMA-RAY ATTENUATION COEFFICIENTS.
P.F.Berry.
Nucleonics (USA), Vol. 19, No. 6, 62 (June, 1961).

Nucleonics Data Sheet No. 42 — Shielding Constants. An extension of Nucleonics Data Sheet No. 10 to include low photon energies. A set of graphs enables mass absorption coefficients to be found as a function of atomic number for energies from 10 MeV to 1.8 keV. R.D.Smith

13376 CURRENTS FROM GAMMAS MAKE DETECTORS AND BATTERIES. B.Gross and P.V.Murphy.
Nucleonics (USA), Vol. 19, No. 3, 86, 88-9 (March, 1961).

Compton electrons produced in a solid insulator are collected and used as a source of current or as a measure of gamma intensity. A typical gamma battery has a 1000 curie Co^{60} source surrounded by 2 cm of polystyrene, coated externally with a thin conducting film. Compton electrons are driven outwards making the outer film negative and producing a current of 0.1 μA at 500 kV. In a typical radiation detector gamma-rays fall on a Lucite insulator with a copper-foil outer covering and a central lead absorber. Compton electrons are driven into the central lead block which becomes negatively charged. This central block must be thick enough to absorb most of gamma-radiation on reaching it, since gammas penetrating it produce a reverse current. Two detectors are described, one giving a voltage (1 V/r) that can be recorded after several hours storage and the other a current of 71 μμA in a 1r/sec gamma-ray flux. R.D.Smith

13377 A GAS-DISCHARGE GAMMA-RADIATION DETECTOR WITH A LOGARITHMIC SENSITIVITY.
Yu.M.Tolchenov and V.G.Chaikovskii.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 51-2 (Jan.-Feb.).
In Russian.

The detector is in the form of a two-electrode system producing a strongly non-uniform field. It is connected in series with a large load ($\geq 10^{-9}$ ohm) and an h.t. source. When the detector is exposed to gamma-rays, the corona discharge current increases and the resulting drop in the voltage across the detector is a logarithmic function of the gamma-ray intensity. Kr, A or He can be used as the working gas. The possible range of the method is $0.01\text{-}10^6$ r/hr. Voltage changes of 50-100 V can be obtained when the gamma-ray intensity changes by an order of magnitude. S.Chomet

13378 APPLICATION OF SECTOR IONIZATION CHAMBERS TO THE ABSOLUTE MEASUREMENT OF THE INTENSITY OF HIGH-ENERGY GAMMA-RADIATION. I.N.Usova.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 53-5 (Jan.-Feb.).
In Russian.

The sector chamber described in a previous paper [Dokl. Akad. Nauk SSSR, Vol. 104, No. 3, 391 (Sept. 21, 1955)], where it was used for beam-axis location, was modified for use in intensity measurements. Two thin, sector-shaped convertors with different Z-numbers, but equal numbers of electrons per unit area, are employed. The convertors also serve as the high-voltage electrodes (+1500 and −1500 V respectively) and have a common collector. The gamma-ray intensity can be determined, from the difference in the currents from the two convertors, with an accuracy of about 7%. S.Chomet

13379 PRECISION ADIABATIC GAMMA-RAY CALORIMETER USING THERMISTOR THERMOMETRY.

I.T.Myers, W.H.Le Blanc and D.M.Fleming.

Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1013-15 (Sept., 1961).

For most gamma-ray sources, the calorimeter walls are thick enough to absorb more than 99% of the gamma rays emitted by the source being measured. The standard deviation of the mean in the measurement of a half-curie Co^{60} source was 0.2%; that of a half-curie radium source was 0.03%.

13380 ANTICOINCIDENCE GAMMA-RAY SPECTROMETER FOR NEUTRON CAPTURE SPECTROSCOPY.

C.O.Bostrom and J.E.Draper.

Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1024-31 (Sept., 1961).

A total absorption NaI:Tl gamma-ray spectrometer has been assembled and has been tested over the range 0-10 MeV with thermal neutron capture gamma rays. It employs an 8 in. dia. by 12 in. NaI:Tl anticoincidence mantel. The measured width at 8.5 MeV is 3% (full width at half-maximum). Typical spectra are presented. Measurements of efficiency, line shape, and resolution are analysed. The usefulness of this spectrometer for analysis of complex spectra at high efficiency is demonstrated.

13381 CONTINUOUS COUNTING OF GAMMA RAYS FROM HOT RADIOACTIVE LIQUIDS.

F.L.Green and A.Somerville.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 320-2 (April, 1960).

A standard NaI (Tl) scintillation crystal is used continuously to count gamma rays from Fe^{59} which is dispersed in lubricating oil at 270°F. The crystal is mounted in a water-cooled jacket which also serves as a light shield. The crystal and jacket assembly is placed in a well-type sample holder. The system may be used for counting liquids at temperatures much higher than 300°F by increasing the flow of water or by using a refrigerated coolant. Resolution is adequate for counting two gamma rays. The temperature of the electronics cabinet which contains conventional instrumentation is maintained at 105°F by Nichrome heater elements. Drift of <1% occurs when the temperature surrounding the cabinet varies from 70-100°F.

13382 SOME OBSERVATIONS ON THE ENERGY SPECTRUM OF LOW ENERGY BREMSSTRAHLUNG FROM ELECTRONS OF ENERGY $<\sim 10^{12}$ eV.

P.K.Aditya.

Indian J. Phys., Vol. 34, No. 7, 302-6 (July, 1960).

Observations were made on the energy spectrum of photons of energy > 30 MeV emitted by bremsstrahlung from electrons of energy 10^{11} to 10^{12} eV. This observation is of importance from the point of view of checking the influence of the density of the medium. No significant departure from the conventional theory was observed.

13383 THEORETICAL AND EXPERIMENTAL DETERMINATION OF THE BREMSSTRAHLUNG EMITTED BY P^{32} β-RAYS IN Au.

R.Quivy and J.Franeau.

J. Phys. Radium (France), Vol. 22, No. 6, 377-84 (June, 1961). In French.

Relativistic and non-relativistic theoretical formulae, giving the bremsstrahlung cross-section for monoenergetic electrons, are used to calculate the bremsstrahlung produced by P^{32} β-rays in Au. To study this radiation experimentally, a method is proposed for interpreting spectra obtained with a scintillation counter. The experimental results agree satisfactorily with theoretical predictions for thin targets. With thick targets, the intensity of the low-energy radiation is considerably increased. The practical use of this bremsstrahlung is discussed.

13384 ELECTRON BREMSSTRAHLUNG IN THE FIELD OF A NEUTRAL ATOM.

H.Huber.

Z. Phys. (Germany), Vol. 163, No. 4, 382-400 (1961). In German.

A model is employed, approximating the neutral atom to a constant potential U in the interior of a sphere of radius r. The free-free emission coefficient is determined in the general case for an isothermal plasma; in the special case of an impenetrable sphere it is compared with the emission coefficient of the ion bremsstrahlung obtained by the "soft" approximation. The results show that electron-atom radiation may not be neglegible compared with electron-ion radiation, and this fact may be used to explain the experimentally observed increase of emission coefficient with pressure, which is more rapid than linear. This is verified numerically in the limiting case of an impenetrable sphere. In addition the bound-free absorption coefficient is determined both in general and in the special case of the H^- ion; a comparison is
with the absorption coefficient as obtained by Chandrasekhar.
the aid of the "best approximation" method, given in conclusion,
the quantities U and r may be determined for any neutral atom.

13385 ELECTRON—PROTON BREMSSTRAHLUNG.

R.A.Berg and C.N.Lindner.

Nuclear Phys. (Internat.), Vol. 26, No. 2, 259-79 (Aug., 1961).

The electron—proton bremsstrahlung cross-section is calcu
in the first Born approximation, neglecting radiative correction
to the electron. As an extension of an earlier calculation, the
proton Compton effect contribution is analysed in its most gene
form. It involves twelve form factors of three invariants,
$f_j(\nu_1, \nu_2, \nu_3)$, where j = 1, ..., 12. The cross-section is stated
explicitly in terms of these twelve functions and the two form
factors of one invariant describing the proton vertex. The contr
tions to the f_j from (a) the single nucleon intermediate state, (b)
one-meson, one-nucleon intermediate state and (c) the neutral p
exchange, are calculated. These three contributions are expect
to be the major effects when the energies involved are in the ra
of present experimental interest. To order $(1/M)^2$, only three
combinations of these twelve f_j will contribute to the cross-sect
When only (a) and (b) are considered, only two of these three
combinations are independent. Some numerical values for a
bremsstrahlung coincidence experiments are presented.

13386 PLANE POLARIZATION OF 8.5 MeV BREMSSTRAH LUNG.

K.Shoda.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1271-80 (July, 1961).

The polarization produced by 8.5 MeV electrons incident on
thin Al, Ag, Au and U targets in a betatron was studied with D_2O
loaded nuclear emulsions. The polarization was measured at th
characteristic emission angle $\theta = mc^2/E_0$ by observing the azim
angular distribution of photoprotons from deuterons. The resul
show different energy dependence of polarization for different
elements. For low Z targets the polarization is positive and la
in the lower energy part of bremsstrahlung spectrum, in qualita
agreement with the theoretical calculations. For high Z targets
polarization is negative in the higher energy range and positive
lower energy range. This reversal of the sign of polarization o
at much lower energies than those expected from the theory.

13387 EFFECTS OF SCREENING AND MULTIPLE SCATT ING OF PRIMARY ELECTRONS ON THE POLARISA TION OF BREMSSTRAHLUNG.

H.Banerjee.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 681-6 (Nov. 26, 19

It is shown that an idea of the effects of screening on the
bremsstrahlung cross-section can be obtained from some gene
considerations without referring to any particular atomic form
factor. Explicit expressions for the polarization dependent cro
sections are obtained on the assumption of exponential screenin
The intrinsic energy-angle distribution of the bremsstrahlung t
obtained is then combined with the Moliere theory of multiple sc
tering for the primary electrons (Abstr. 609 of 1949). It is fou
that at least for forward emission, the energy dependence of the
polarization of bremsstrahlung is hardly affected by the conside
tions of multiple scattering.

13388 EMERGENCE INTO VACUUM OF THE CHERENKOV RADIATION PRODUCED FROM LONGITUDINAL WAVES IN A MEDIUM.

B.L.Zhelnov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 170-7 (Jan., 1961)
In Russian.

The problem treated is that of the radiation from an electr
that moves into vacuum from a medium with spatial dispersion.
The additional boundary conditions required to take spatial disp
into account are discussed. It is shown that under certain condi
in addition to the transition radiation there is Cherenkov radiat
produced from longitudinal waves in the medium and emerging
the vacuum. For the case of small absorption in the medium th
angular distribution of this radiation is determined by the law o
refraction together with the condition for Cherenkov radiation i
medium. The main contribution to the transition radiation is th
Cherenkov radiation from longitudinal waves, which is produced
the medium near the bounding surface (at a distance of the orde
the wavelength). At large distances from the boundary this part
the Cherenkov radiation is a spherical wave and is confined to a
narrow range of frequencies lying close to the plasma frequency
[English translation in: Soviet Physics - JETP (USA), Vol. 13,
117-22 (July, 1961)].

9 OBSERVATIONS ON ČERENKOV RADIATION FROM THE NIGHT SKY.
e, N.A.Porter and C.D.Long.
s. terrest. Phys. (GB), Vol. 20, No. 1, 40-8 (Feb., 1961).
ht pulses from extensive air showers were studied with a of four wide-angle detectors in coincidence. The zenith istribution was determined by a timing method, and the rate ers observed under cloud. Most of the light observed to originate from altitudes of less than 1 km. The results reconciled with previous work if it is assumed that the distribution of the light at emission is very wide; the d characteristics of the shower are then determined ally by the field of view of the receiver.

rinos

RANGE NEUTRINO AND A COMPOSITE MODEL FOR NTARY PARTICLES . See Abstr. 13308

E STRUCTURE OF MOMENTUM SPACE, THE NEUTRINO E PAULI PRINCIPLE. See Abstr. 13273

90 ABSORPTION OF HIGH ENERGY NEUTRINOS.
G.Marx and M.Elkishem.
ys. Hungar., Vol. 12, No. 3, 257-62 (1960).
ong the interactions of elementary particles only the coupling t of the weak interaction possesses any physical dimension nal units ($\hbar = c = 1$). This is shown to lead to the possibility ypes of neutrinos, characterized by fermion- and boson-type respectively. A perturbation-theoretic calculation of the ion of these neutrinos by nucleons is made, the absorption ection being related to the neutrino and recoil energies, and nents are suggested to test the existence of either or both f neutrinos. J.W.Gardner

trons

1 THE DETERMINATION OF m/e FOR FREE ELECTRONS BY MOMENTUM TRANSFER.
w and F.S.Harris, Jr.
hys. Soc. (GB), Vol. 78, Pt 3, 433-37 (Sept., 1961).
ew method is described for measuring m/e for free elec- A Faraday cage mounted on a torsion device collects elec- om an electron gun. The change in maximum angular dis- ent of the fibre with electron beam on and off together with sured current gave a value of m/e of 5.82×10^{-12} kg C^{-1} ed to the accepted value of 5.6854×10^{-12} kg C^{-1}.

2 ELECTRODYNAMIC CORRECTIONS TO MAGNETIC MOMENT OF ELECTRON. P.Smrž and I.Úlehla.
J. Phys., Vol. 10, No. 12, 966-8 (1960).
e deviation of the magnetic moment of an electron from the agnetron is recalculated to fourth order in electron charge. ult of previous work is fully confirmed. F.Herbut

3 SCATTERING OF FAST ELECTRONS.
P.Urban and H.Zingl.
r. Phys. (Germany), Vol. 7, No. 12, 641-74 (1959).
an.
eview of papers published after the review articles of Fortschr. Phys. (Germany), Vol. 3, 1(1955); Vol. 5, 93 (1957)] stadter (Abstr. 2524 of 1957). W.A.Hepner

4 SCATTERING OF BeV ELECTRONS BY HYDROGEN AND DEUTERIUM.
tauer, H.F.Schopper and R.R.Wilson.
ev. Letters (USA), Vol. 7, No. 4, 141-3 (Aug.15, 1961).
e differential cross-sections for elastic scattering of s of energy from 317 MeV to 1166 MeV by protons, and the oss-sections for scattering by deuterons, are given, in the ory frame, for 45°, 90° and 135°, the Schwinger correction ation being applied. The dependence of these parameters ent electron energy and laboratory scattering angle is raphically. A quadrupole magnet spectrometer of large gle was used in the measurements. I.C.Demetsopoullos

13395 HIGH-ENERGY ELECTRON SCATTERING PROCESSES.
S.S.Sannikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 237-45 (Jan. 1961).
In Russian.

A method is developed for calculating cross-sections of various processes involving fast polarized electrons, which can be described by two-component spinors. Some helicity properties of the electrons are elucidated. The pair-production cross-section in electron-positron collisions is found. [English translation in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 163-8 (July, 1961)].

13396 ABSORPTION CURVE OF THE Y^{90} β-RADIATION IN LIGHT ELEMENTS. J.Friedländer.
Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 1, 97-102 (1960).
In Roumanian.

Deviations from logarithmic linearity of the attenuation of the Y^{90} β-radiation in light elements are described by an empirical relationship implying two parameters. Possible uses of the newly introduced parameter are discussed.

13397 COUNTING SOFT BETAS.
D.R.Christman.
Nucleonics (USA), Vol. 19, No. 5, 51-5, 64 (May, 1961).

Various methods available including solid counters, gas counters and scintillators are compared on a basis of sensitivity, precision, intensity limits and cost. A bibliography is included. R.D.Smith

13398 A SECOND-ORDER FOCUSING β-SPECTROGRAPH.
P.Paris.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 54, 65-73 (March, 1961). In French.

A theoretical treatment for a high-resolution sector spectrograph is given, following the principle described by Fowler. The prototype of this design was constructed and tested using sources prepared from radiothorium. A resolution of one part in 1000 was obtained for sources of energy >200 keV, in agreement with theory. Comparison of the time required for exposure in this instrument and a 180° spectrograph yielded a factor of up to 3 to 2 in its favour. It is intended for use with long-lived, low-intensity sources. V.M.Rout

13399 IRON-FREE TOROIDAL BETA—BETA COINCIDENCE SPECTROMETER. M.S.Freedman, F.Wagner, Jr, F.T.Porter, J.Terandy and P.P.Day.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 2, 255-6 (Aug., 1960).

The design of an iron-free, double-toroidal β—β coincidence spectrometer, detecting a maximum β-energy of 3.5 MeV, is outlined. It is possible to perform β—β and β—γ angular correlation measurements and triple-coincidence experiments. A preliminary description of the construction and performance of the first toroid is given. V.M.Rout

13400 CALCULATIONAL METHODS FOR USE WITH β-SPECTROMETERS. F.Fritsch.
Z. Instrumkde (Germany), Vol. 68, No. 11, 271-3 (Nov., 1960).
In German.

Discusses the calculation of the true electron energy spectrum from a measured spectrum using a β-ray spectrometer by a function analogous to the frequency response in electrical communication theory or the constant transfer function in optics. R.H.Thomas

13401 A POSITRON COW.
G.I.Gleason.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 90-4 (July, 1960).

Short-lived Ga^{68} can be prepared from its long-lived parent, Ge^{68}, thus providing a convenient source of positron-emitting activity for medical or other applications. Solvent extraction is used for the rapid separation of the gallium daughter and a method for the production of the germanium parent is given. A review of the usable positron emitters serves to underscore the advantages of the Ge—Ga^{68} system.

13402 TWO-QUANTUM ANNIHILATION OF POLARIZED POSITRONS. D.Babala.
Czech. J. Phys., Vol. 10, No. 9, 628-32 (1960).

The cross-section for the two-quantum annihilation-in-flight of partially polarized beams of β particles, obtained by using the polarization density matrix, is given. The formula includes the special results of Page (See Abstr. 5606 of 1957). The annihilation of a longitudinally polarized positron with a transversally polarized electron is discussed. Computations are made in a centre-of-mass system with summing over photon polarizations.

13403 THE SCATTERING OF LOW-ENERGY ORTHO-POSITRONIUM BY HYDROGEN ATOMS. P.A.Fraser.

Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 329-47 (Sept., 1961).

When ortho-positronium collides with a hydrogen atom not only may it be scattered, but there is also the possibility of conversion of the ortho-positronium to para-positronium by electron exchange. The total elastic cross-section and the conversion cross-section are calculated for positronium kinetic energies 0 to 9.8 eV, for the $l = 0$ partial wave only. A particular choice of trial wave-function explicitly satisfying the Pauli principle and a variational argument lead to integro-differential equations, with no "ordinary force", from which the phase shifts are obtained by a numerical method. The cross-sections are very strongly energy-dependent: the total cross-section ranges from $192\pi a_0^2$ at zero energy to $2.92\pi a_0^2$ at 6.9 eV, while the (conversion)/(total) ratio ranges from 0.176 to 0.070 over these energies. These ratios are well below the value $\frac{1}{4}$ expected at high energies from the Born approximation. The total cross-section results of Massey and Mohr (Abstr. 9579 of 1954) for this problem using Born approximation were $230\pi a_0^2$ at zero energy and $25\pi a_0^2$ at 6.8 eV, with the (conversion)/(total) ratio $\frac{1}{4}$.

Nucleons

13404 ELECTRIC AND MAGNETIC POLARIZABILITIES OF THE NUCLEON.

V.S.Barashenkov, H.J.Kaiser and A.A.Ogreba.

Nuovo Cimento (Italy), Vol. 20, No. 3, 593-5 (May 1, 1961).

The nucleon electrical and magnetic polarizabilities α and β are evaluated theoretically with the aid of dispersion relations to a higher degree of precision than had been done previously. These theoretical values ($\alpha \cong 12 \times 10^{-43}$ cm^3, $\beta \cong -0.2 \times 10^{-43}$cm^3) are close to those obtained from the direct analysis of the experimental data on the Compton effect on the proton together with the photoproduction of pions on the proton ($\alpha \cong 5.5 \pm 2.3 \times 10^{-43}$cm^3, $\beta = 2 \pm 2 \times 10^{-43}$cm^3). C.Wilkin

13405 ELECTRIC POLARISABILITY OF NUCLEON. T.Sawada.

Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1132-4 (Nov., 1960).

Using dispersion relations, an expression is found for the electric polarization of the nucleon in terms of the total cross-section for electric multipole photon scattering. The main contributions come from photomeson production. Estimates of the neutron and proton polarizations are given. I.J.R.Aitchison

13406 HIGHER MOMENTS OF THE CHARGE AND MAGNETIC MOMENT DISTRIBUTIONS OF NUCLEONS.

V.B.Berestetskii and M.V.Terent'ev.

Zh. eksper. teor.Fiz. (USSR), Vol. 40, No. 1, 324-7 (Jan., 1961).
In Russian.

The unitarity condition with only two-pion intermediate states included is used to calculate the moments of the charge and magnetic moment distributions of nucleons. Asymptotic expressions for these moments are obtained. A calculation is made of how the phase-shifts in electron scattering from such nucleons differ from the phase-shifts that would be obtained for point nucleons. [English translation in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 220-2 (July, 1961)].

13407 ON THE INELASTICITY IN HIGH-ENERGY NUCLEAR INTERACTIONS. S.Matsumoto and S.Mikamo.

J. Phys. Soc. Japan, Vol. 16, No. 2, 350-1 (Feb., 1961).

An analysis of cosmic-ray showers in emulsions showed that in a nucleon—nucleon collision, the average value of the ratio of all the energy of created particles to the available kinetic energy of the nucleons before collision in the centre-of-mass system does not change greatly with increasing energy at least up to several tens GeV. E.A.Sanderson

13408 ANTINUCLEON—NUCLEON ANNIHILATION TO T MESONS. R.J.N.Phillips.

Nuclear Phys. (Internat.), Vol. 25, No. 2, 348-52 (May, 1961).

A partial wave description is given for two-meson annihila in flight. Angular distributions and polarization effects are ill rated; they are sensitive to the range of the annihilation regio

Protons

13409 STUDY OF THE STRUCTURE OF THE PROTON B MEASUREMENT OF THE DIFFERENTIAL CROSS-SECTION FOR SINGLE π^0-MESON PHOTOPRODUCTION, AND USING THE COMPTON EFFECT.

G.Cortellessa, A.Reale and P.Salvadori.

RC Ist. Super. Sanita (Italy), Vol. 23, Pt 12, 1177-97 (1960).
In Italian.

The general aspects of the problem of the nucleon structu are discussed within the framework of π-meson physics so far as photoprocesses are concerned. Experimental results for th differential cross-sections for π^0-photoproduction for a range incident photon energies between 500 and 850 MeV are present A discussion of the Compton effect and the results of some mea ments are appended. S.J.St-L

13410 THE REACTION $p+d \rightarrow t+\pi^+$ AT 670 MeV PROTO ENERGY. Yu.K.Akimov, O.V.Savchenko and L.M

Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 2, 643-4 (Feb., 196
In Russian.

The differential cross-sections at 12° and 25° centre-of-m for $p + d \rightarrow t + \pi^+$ were found to be $(9.3 \pm 0.5) \times 10^{-30}$ and $(3.1 \pm 0.5) \times 10^{-30}$cm^2 sterad^{-1} respectively. Calculations bas on a hard-core nuclear model with impulse approximation gi values of 3.1×10^{-30} and 2.4×10^{-30} cm^2 sterad^{-1} respectively. The disagreement is considered to arise from the neglect of th reaction $p + p \rightarrow n + p + \pi^+$ in the analysis of the relation betw $p + d \rightarrow t + \pi^+$ and $p + p \rightarrow d + \pi^+$. [English translation in: Sovi Physics - JETP (USA), Vol. 11, No. 2, 462-3 (Aug., 1960)]. E.J.

13411 QUASI-ELASTIC SCATTERING OF 153 MeV PROT BY PROTONS IN THE p STATE OF C^{12}.

T.J.Gooding and H.G.Pugh.

J. Phys. Radium (France), Vol. 21, No. 5, 326-8 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Gren 1960 (see Abstr. 12029 of 1961). Energy spectra and angular c lations were measured for the reaction $C^{12}(p, 2p)B^{11}$ at 153 MeV the case in which the B^{11} is left in states of low excitation. The sults are consistent with the mechanism of quasi-elastic scatte when the momentum distribution of the struck protons is taken account.

13412 DETERMINATION OF THE [WOLFENSTEIN] PARA METER R IN 142 MeV PROTON SCATTERING.

L.Birds, D.N.Edwards, B.Rose, A.E.Taylor and E.Wood.

J. Phys. Radium (France), Vol. 21, No. 5, 329-31 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Greno 1960 (see Abstr, 12029 of 1961). Results are reported of a mea ment of the Wolfenstein parameter R for p—p scattering at 142 covering the angular range 24° to 90° c.m. These results toget with other data referring to the same energy were used by Per in a phase-shift analysis, preliminary results of which are also presented. Measurements were also made at the same energy the R parameter of some elements.

13413 ON THE "QUASI-ELASTIC DIFFRACTION" SCATT ING OF HIGH-ENERGY PROTONS. B.T.Feld and

Nuovo Cimento (Italy), Vol. 21, No. 1, 59-68 (July 1, 1961).

The observations of Cocconi et al (Abstr. 7243 of 1961), on "quasi-elastic diffraction" scattering of (10 – 25) GeV/c proton nucleons, are explained as resulting from "isobar" excitation o target nucleons. The experiments are shown to provide evidenc the excitation of the first three levels. Some physical argument are presented concerning the nature of the excitation process a its energy and angular dependence.

.4' A SEPARABLE POTENTIAL FOR THE TWO-NUCLEON (T = 1) INTERACTION. A.N.Mitra and J.H.Naqvi.
Phys. (Internat.), Vol. 25, No. 2, 307-16 (May, 1961).
eparable potential in the isobaric state T = 1 is proposed on
s of p—p scattering data up to about 100 MeV. The triplet
otential is taken to be purely of the spin—orbit type, with
about half of that of the singlet potential. Potentials in
≥ 3 are neglected. It is found that such a potential can
atisfactorily explain the angular shape of the unpolarized
ection as well as the magnitude of the polarization in
ng up to 100 MeV.

5 ELASTIC SCATTERING AND SINGLE MESON PRODUCTION IN PROTON—PROTON COLLISIONS
BeV. G.A.Smith, H.Courant, E.C.Fowler, H.Kraybill,
eiss and H.Taft.
ev. (USA), Vol. 123, No. 6, 2160-7 (Sept. 15, 1961).
Brookhaven National Laboratory twenty-inch liquid
n bubble chamber was exposed to a monoenergtic beam of
V protons, elastically scattered from a carbon target in
rnal beam of the Cosmotron. Elastic scattering was found
ostly pure diffraction scattering at centre-of-mass angles up
thirty-five degrees. Some phase shift and/or tapering of
on edge was required to fit the data at larger angles. No
tion effects in the proton—carbon scattering were observed
drogen as an analyser of polarized protons. Nucleonic
ormation in the T = 3/2, J = 3/2 state was found to account
rge part of single pion production. High orbital angular-
um states were found to be greatly favoured in single-pion
ion. The isobar model of Lindenbaum and Sternheimer gave
reement with the observed nucleon and pion energy spectra.
rization or alignment effects were observed for the isobar
d in this model.

16 PROTON—PROTON SCATTERING BELOW 50 MeV. J.Iwadare.
hys. Soc. (GB), Vol. 78, Pt 2, 185-96 (Aug., 1961).
imple qualitative interpretation of the results of detailed
hift analyses is attempted for the low-energy p—p
ng. The following conclusions are obtained: In general,
e four sets of phase shift solutions, two of which corres-
the right sign of the tensor potential. One of them
onds to the pure tensor potential, the other to a mixture of
or and the $\vec{L}.\vec{S}$ potentials. To decide between these two
ities the combined measurements of C_{nn} and one of the
cattering parameters are the most convenient and feasible
ents. It is also shown that a version of the pion potential
d by Hamada et al. (Abstr. 20072 of 1960) is compatible
angular distribution below 5 MeV.

7 ON THE SMALL-ANGLE SCATTERING OF HIGH-ENERGY PROTONS. S.Ohnuma.
theor. Phys. (Japan), Vol. 25, No. 1, 158-9 (Jan., 1961).
cusses the importance of including the small phase-shifts
igh partial waves of N—N scattering in the calculation of the
ngle polarization. J.E.Paton

8 POLARIZATION IN PROTON—BERYLLIUM AND PROTON—PROTON SCATTERING AT 1.7 GeV.
yre, J.F.Detoeuf, L.W.Smith, R.D.Tripp and L.Van Rossum.
Cimento (Italy), Vol. 20, No. 6, 1049-66 (June 16, 1961).
polarization in p—Be and p—p scattering was measured by
techniques at a proton kinetic energy of 1.74 GeV. The
m polarization in p—Be scattering was found to be P_{max} =
0.04 and occurs at an angle $\theta_{max} \gg 3.5^{\circ}$. Inelastic
s were rejected when the inelastic momentum loss was more
ut 1% in the first scatter (magnetic analysis) or more than
in the second scatter (Cherenkov threshold counter). The
m polarization in p—p scattering is $P_{max} = 0.30 \pm 0.99$ and
t an angle $35^{\circ} < \theta_{max} < 55^{\circ}$ (cm). The angular dependence
larization is consistent with a distribution proportional to
within large statistical errors. Optical model calculations
to the data on p—Be scattering yield an almost all imaginary
potential of about 43 MeV and a spin—orbit potential of
0.9 MeV and 2.0 MeV which is also almost all imaginary,
st with the predominantly real spin—orbit potential needed
n the large polarization in the region of several hundred

13419 USE OF A NUCLEAR EMULSION AS AN ANALYSER OF PROTON POLARIZATION: APPLICATION TO THE POLARIZATION OF PROTONS IN THE PHOTODISINTEGRATION OF THE DEUTERON. B.T.Feld, B.C.Maglić and J.Parks.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 2, 241-52 (1960).

The use of a nuclear emulsion as an analyser of proton polarization at an energy of 150 MeV was studied experimentally by two different methods of scanning. An analyzing power of $+0.47 \pm 0.08$ was obtained for scattering angles of 5° - 20°. As an application of the emulsion method, the excitation function of the reaction $\gamma + d \rightarrow n + p$ was measured from 150 to 300 MeV, and the polarization of protons produced by photons of $E_{\gamma} = (250 \pm 40)$ MeV. The most likely value of the polarization was determined to be $+0.27^{+0.16}_{-0.18}$ at 45° c.m. angle.

13420 PROTON POLARIMETERS WITH REDUCED SENSITIVITY TO NEUTRON AND GAMMA BACKGROUNDS. A.K.Val'ter, A.P.Klyucharev and N.A.Skakun.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 20-2 (Jan.-Feb.).
In Russian.

Two devices for measuring the polarization of protons, having energies up to 20 MeV, are described. In the first polarimeter, elastic p—He^4 scattering is used and the polarization can be measured between 30° and 150° to the incident beam. The absolute counting efficiency of the polarimeter was found to be 10^{-5} at 18 MeV. The second polarimeter is based on p—C^{12} elastic scattering at 45°. In both cases neutron and gamma-ray backgrounds are excluded by detecting the scattered protons with a proportional and a scintillation counter arranged in coincidence. It is intended to use these polarimeters in studies of the polarization of protons from the $He^3(d,p)He^4$ reaction. S.Chomet

13421 HIGH-VELOCITY RANGE AND ENERGY-LOSS MEASUREMENTS IN Al, Cu, Pb, U AND EMULSION.
W.H.Barkas and S. von Friesen.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 41-62 (1961).

Measurements were made of relative stopping powers of several materials in the proton energy intervals (750-600) MeV, (600-450) MeV, (450-300)MeV and (750-0)MeV. By collimation and magnetic analysis a "pencil beam" free of degraded particles was extracted from the 184 in. cyclotron. Using this beam in "good geometry" the stopping powers of Al, Pb, U and emulsion were measured relative to Cu. The total ranges yield the most accurate estimates of the mean excitation potentials. It is assumed that the mean excitation potential of Al is 163 eV, and that at 750 MeV substantially all the tight binding corrections required are those for the K and L shells. The mean excitation potentials in eV found with these assumptions are: copper, 323; lead, 826; uranium, 917; and emulsion, 328. The results from the differential stopping-power measurements are in general accord with these data. However, the agreement of the differential measurements with the theoretical ratios could be improved by raising the above mean excitation potentials of Al and Pb or by lowering those of copper, uranium and emulsion. This experiment confirms the general shape of the I/Z verus Z curve found by Bakker and Segre, and when similarly normalized, is in reasonable absolute agreement. The status of the emulsion range-energy table is reviewed in the light of these and other relevant measurements. Incidental observations were made on the scattering straggling and attenuation behaviour of a highly collimated monoenergetic beam of protons which was brought to rest in a large block of copper.

RATIO OF ATOMIC STOPPING POWER OF GRAPHITE AND DIAMOND FOR 1.1 MeV PROTONS. See Abstr. 12349

13422 A PROPOSED EXPERIMENTAL TEST OF THE DAY, SNOW AND SUCHER ARGUMENT BASED ON ANTI-PROTON ANNIHILATION INTO KAONS. B.d'Espagnat.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1217-18 (June 16, 1961).
See Abstr. 13732 of 1959.

13423 PION—PION INTERACTIONS AND PROTON—ANTI-PROTON ANNIHILATION AT REST.
V.De Alfaro and B.Vitale.
Nuovo Cimento (Italy), Vol. 21, No. 1, 197-9 (July 1, 1961).

Three main points have been discussed recently concerning the pion annihilation of nucleon—antinucleon pairs at rest, namely: (a) the validity of the argument in favour of absorption from S initial states; (b) the indication on the spin state (singlet or triplet) of the annihilating pair derived from the observed pair states;

(c) the influence of the T = J = 1 resonant pion—pion state on the angular and energy distributions of the pions produced. The authors claim that more information can be obtained by discussing these three points together, than separately, as has been done hitherto.
J.H.Gunn

Neutrons

13424 NEUTRON TERMINOLOGY.

W.R.Harper.

Nature (GB), Vol. 191, 60 (July 1, 1961).

The author contends that the introduction of the term "flux density" to designate neutron density times mean speed, as suggested by Ghose and Young (Abstr. 9696 of 1961), would lead to greater confusion in terminology. He feels that the meaning at present attached to "neutron flux" can be justified, but that the term "macroscopic cross-section" (having dimensions L^{-1}) cannot, and should be replaced by terms such as "absorption coefficient". Further, "multiplication constant" should be reserved for a regular fuel—moderator lattice of infinite extent, while for a real reactor, "reproduction ratio" would be appropriate.
J.E.Gore

13425 NEUTRON "FLUX".

K.L.Stretch.

Nature (GB), Vol. 191, 60 (July 1, 1961).

The term "neutron flux" does not represent neutron flow except in special cases, but rather the rate of generation of neutron track lengths per unit volume. A preferred alternative is neutron (collision) potential, since, in reaction problems, the flux is a measure of this.
J.E.Gore

13426 ELASTIC AND INELASTIC SCATTERING OF NEUTRONS BY DEUTERONS NEAR THE INELASTIC THRESHOLD.

L.M.Delves.

Nuclear Phys. (Internat.) Vol. 26, No. 1, 136-46 (July, 1961).

A calculation is made of the neutron—deuteron s-wave elastic and inelastic scattering cross-sections which includes the interaction between these two channels. The scattering matrix given by this method is unitary. Comparison is made with a calculation of the elastic scattering using the same potentials but neglecting the effect of the inelastic channel. Large differences are found, indicating that it is important to include the deuteron distortion in elastic scattering calculations; however, this conclusion may be due at least partly to neglect of charge exchange scattering. The proton energy spectrum predicted by the model is the phase-space spectrum. This is identical with that of Frank and Gammel (Abstr. 4933 of 1954) except near the upper end of the spectrum, where it agrees better with experiment at the energies considered. The size of the anomaly in the elastic scattering cross-section at the inelastic threshold is calculated, and found to be rather small.

13427 NEUTRON—PROTON PHASE-SHIFT ANALYSIS AT 95 MeV.

M.H.MacGregor.

Phys. Rev. (USA), Vol. 123, No. 6, 2154-6 (Sept. 15, 1961).

A phase-shift analysis of neutron—proton differential cross-section and polarization measurements at 95 MeV was carried out. With the isotopic-spin-one phase shifts taken from the results of proton—proton phase-shift analyses at the same energy, only one set of isotopic-spin-zero phase shifts was obtained that gave a good least-squares fit to the data. The analysis indicates that the forward and backward peaks in the neutron—proton differential cross-section at 95 MeV are predominantly triplet- and singlet-spin scattering states, respectively.

13428 NEUTRON SCATTERING ON PROTONS FROM THE VIEWPOINT OF THE π-MESON PAIR DOUBLET.

Yu.M.Lomsadze, V.I.Lend'yel, I.Yu.Kriȳs'kȳi.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 123-5 (1959). In Ukrainian.

13429 THE SCATTERING OF SUBTHERMAL NEUTRONS BY H_2O, CH_2O_2 AND C_6H_6.

K.Heinloth.

Z. Phys. (Germany), Vol. 163, No. 2, 218-29 (1961). In German.

Measurements are reported of the total neutron cross-section for H_2O, CH_2O_2 and C_6H_6 at neutron energies ranging from 0.2×10^{-3} to 2.7×10^{-3} eV and again at 36×10^{-3} eV. For each substance the temperature range (−100° to +200°C) includes the solid, liquid and gas phases. For any given phase the total cross-section increases monatonically with temperature but there are jumps at the tr sition temperatures: an increase occurs in passing from soli liquid and a decrease in passing from liquid to gas. The form be explained in terms of a decrease in the effective Debye tem ture in passing from solid to liquid. (For H_2O, it is estimated Θ_D (solid) = 280°K and Θ_D (liquid) = 160°K). The drop in cros-section at the boiling point (which is rather small in the case is thought to be associated with the disappearance of hindered tional oscillations on passing to the gas phase.
R.O.H.

13430 ON THE ELECTRICAL POLARIZABILITY OF TH NEUTRON.

N.Martalogu and I.Minzatu.

Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 2, 303-13 (196
In Roumanian.

The electrical polarizability constant α is estimated, by us symmetrical pseudoscalar meson theory, in the nonrelativisti approximation. When comparing the obtained value with other it is concluded that the present one, fully agrees with the data obtained from the experimental photoproduction of pions and C scattering of nucleons; but in the case of fast neutrons scatter heavy nuclei the same value no longer agrees with the data obt In the second part of the work, some considerations are made effects of the spin and electrical polarization in the elastic diff ial scattering cross-section of the fast neutrons in heavy nucle

13431 THE [NEUTRON] DIFFUSION LENGTH OF A CRYSTALLINE POWDER AND THE DISTORTION THE MAXWELL SPECTRUM.

A.Herpin and D.Saint James.

J. Phys. Radium (France), Vol. 22, No. 4, 193-203 (April, 1961
In French.

A calculation of the diffusion length is developed, taking in account the difference in mean free path between neutrons of w length greater than the first Bragg wavelength and those of sm wavelength. This allows an indirect determination of the effe absorption cross-section. The Maxwell distribution is shown suffer distortion. The calculation is then applied to the cases beryllium and beryllium oxide.

13432 COMPARISON THEOREMS FOR THE ESTIMATIO AVERAGE COLLISION PROBABILITIES. II.

L.Dresner.

Nuclear Sci. Engng (USA), Vol. 7, No. 3, 260-2 (March, 1961).

For Pt I, see Abstr. 12959 of 1960, in which theorems are given for the estimation of average collision probabilities for convex solids of irregular shape by comparison with solids for which the average collision probability is known, is extended.

13433 VELOCITY DEPENDENT NEUTRON TRANSPORT THEORY.

W.R.Conkie.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 295-303 (April, 1960).

A method of extending the spherical harmonics method to calculation of velocity-dependent neutron transport processes described. Application of the method is made to a variation of Milne problem with the model of an ideal gas of unit mass for scattering medium. The results indicate that the method can g accurate analytical expressions for the neutron density for suc velocity-dependent problems.

13434 THERMAL NEUTRON FLUX SPECTRUM IN A MEDIUM WITH A TEMPERATURE DISCONTINUIT

D.A.Kottwitz.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 345-54 (April, 1960).

The energy-dependent diffusion equation in the heavy gas approximation is considered for the case of a medium which h absolute temperature T_1 in one half-space and T_2 in the other. steady-state solution for F(x, E), the neutron flux per unit ene is obtained in the absence of sinks and sources. Although the formal series solution diverges under certain conditions, it ca "summed" by means of the Euler transformation. Two approxi tion schemes giving simple analytical results are discussed. Numerical results for flux spectra and the total neutron densit presented for the case in which the temperature ratio is 2:1. T connection between this work and the theory of irreversible processes is briefly indicated.

13435 DIFFUSION OF INTERMEDIATE ENERGY NEUTR INTO A THICK RESONANCE ABSORBER.

H.H.Hummel and D.Meneghetti.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 363-8 (April, 1960).

The problem considered is the calculation of the diffusion intermediate energy neutrons from a large moderated region in

ɛsonance absorber. This is of interest for a coupled fast-
. reactor. Boundary conditions at the interface between the
ions appropriate for a P − 1 calculation in the moderator are
;ated. The transport approximation in the moderator is found
good results even for hydrogenous moderator.

36 THE SLOWING DOWN OF NEUTRONS BY DEUTERIUM.

M.M.Levine, K.E.Roach, D.B.Wehmeyer and P.F.Zweifel.
r Sci. Engng (USA), Vol. 7, No. 1, 14-20 (Jan., 1960).
e Greuling—Goertzel method is applied to calculation of the
; down of neutrons in deuterium, and the results compared
e Selengut—Goertzel method, in which the deuterium slowing-
treated by age theory. It is shown how existing codes for
ting slowing down in hydrogen can be modified in a simple
to incorporate this treatment of deuterium. Numerical
show excellent agreement between measured and calculated
nd indicate that a continuous slowing-down model for deuterium
ɔropriate. This is in qualitative agreement with the experi-
ɔerformed by Wade, and in disagreement with Olcott's work.
r. it is shown that an age kernel with an age to indium of
may be used to compute the fast leakage from heavy-water
s over a wide range of buckling. The situation concerning
ent with critical experiments remains to be clarified because
e uncertainties in other criticality factors.

37 AN APPROXIMATE METHOD FOR TREATING NEUTRON SLOWING DOWN.

tzel and E.Greuling.
r Sci. Engng (USA), Vol. 7, No. 1, 69-72 (Jan., 1960).
e slowing down density, q, of neutrons in a reactor may be
ɔosed into a sum of parts due to various nuclear species
$+ q_2 + \ldots$) having corresponding scattering cross sections
$_{s2}$, etc. An approximate relation between q_i and isotropic
u), where u is the lethargy, is proposed:

$$\gamma_i \frac{\partial q_i}{\partial u} + q_i = \xi_i \mu_{si} \varphi \ .$$

lues of γ_i and ξ_i are derived and interpreted.

38 GREULING—GOERTZEL CALCULATIONS IN HEAVY WATER. R.J.Mack and P.F.Zweifel.

r Sci. Engng (USA), Vol. 7, No. 2, 144-6 (Feb., 1960).
e Greuling—Goertzel approximation is applied to the cal-
n of neutron slowing down in heavy water in the B_1 and P_1
imations. Numerical calculations of the flux and nonescape
ility assuming constant cross sections indicate the
sistent" G—G B_1 approximation to be the most favourable.
g machine codes can readily be modified to this method.

39 THE DECAY OF A THERMALIZED NEUTRON PULSE.

M.Nelkin.
r Sci. Engng (USA), Vol. 7, No. 3, 210-16 (March, 1960).
improved theoretical basis is presented for the interpreta-
the pulsed-neutron technique for measuring thermal-neutron
tion cross sections and transport parameters. A procedure
for the exact solution of the Fourier-transformed, multi-
y transport equation in an infinite medium. The objective is
culation of the decay constant of the thermalized neutron flux
ng an initial pulse of fast neutrons. The method used is an
ion of the decay constant and neutron spectrum in a power
in the Fourier-transform variable. The procedure is first
ited for the case of isotropic scattering and then generalized
tropic scattering by using the spherical harmonics expansion.
sults are given in terms of integral equations whose solution
s a knowledge of the energy-transfer cross sections between
l neutrons and the moderating material. The approach
ed is to extract the maximum amount of information which is
ndent of these cross sections and to derive explicitly the
ns involving them. It is necessary to solve these equations
r to obtain more accurate information. Finally, the relation
nfinite medium Fourier transform variable to the geometric
g of a finite sample is discussed.

40 DETERMINATION OF THERMAL NEUTRON ABSORPTION CROSS-SECTION IN BORON USING ICAL TRANSMISSION METHOD. G.Singh and A.K.Ghatak.

Nat. Inst. Sci. India A, Vol. 27, No. 3, 216-22 (May, 1961).
e thermal neutron absorption cross-section of boron was
ined to be 759 ± 11 barns by using a spherical transmission
and measuring the attenuation in the thermal neutron flux
in boric acid solutions. The effect of multiple scattering of the neutrons in the absorber itself was taken into account. The effective neutron temperature is discussed.

13441 SLOWING DOWN OF NEUTRONS IN GRAPHITE CLOSE TO THERMAL EQULIBRIUM.

L.S.Kothari and P.G.Khubchandani.
Nuclear Sci. Engng (USA), Vol. 7, No. 3, 240-4 (March, 1960).

Elastic and one-phonon inelastic scattering cross-sections of neutrons in graphite were calculated for neutron energy less than 2000 k_0. For the lattice vibrations in graphite, the model proposed by Krumhansl and Brooks was used. The mean energy loss per collision and the mean logarithmic energy decrement were also calculated. Assuming that close to equilibrium the neutron distribution remains Maxwellian, the time variation of the temperature of this distribution was calculated. The slowing down relaxation time near equilibrium comes out to nearly 170 μsec, which compares well with the experimental value of 185 ± 45 μsec.

13442 SLOWING DOWN OF NEUTRONS.

T.Teichmann.
Nuclear Sci. Engng (USA), Vol. 7, No. 4, 292-4 (April, 1960).

It is shown how systematic application of Laplace transform methods enables calculation of the neutron collision density in a nonabsorbing medium not only for large values of the lethargy but also for small lethargy values corresponding to small numbers of collisions. As a result, it is not necessary to solve the differential equations for the collision density between collisions.

13443 INELASTIC MODERATION OF FAST MONOENERGETIC NEUTRONS. C.A.Heusch.

Nukleonik (Germany), Vol. 2, No. 6, 228-40 (Nov., 1960).
In German.

The inelastic collision properties of fast neutrons on heavy nucleii (Pb, Bi) were determined using monoenergetic neutron beams produced by D—D and D—T reactions in irradiated targets. These beams were passed into various spheres of lead and bismuth and their migration lengths measured by activation foils. From these results and collision numbers, obtained by Springer from Monte-Carlo calculations, the mean energy losses at each inelastic collision, were calculated. The nuclear temperatures and their variation with incident neutron energy were also calculated and found to agree well with theoretical values and those obtained from similar experiments.

D.H.Lord

13444 ABSOLUTE MEASUREMENT OF THERMAL NEUTRON ABSORPTION IN CHLORINE. A.M.Ghose.

Trans Bose Res. Inst. (India), Vol. 24, No. 1, 7-13 (March, 1961).

The thermal neutron cross-section of chlorine was measured by the sphere transmission technique as 31.0 ± 2.0 barns. Errors due to multiple scattering, moderator scattering, beam hardening and other sources of errors, essentially dependent on the thickness of the absorber, were eliminated by extrapolation of the measured cross-section to that for infinitesimally small thickness of the absorber. The experimental arrangement incorporates a mechanical device for averaging neutron intensity over 4π solid angle. Effects of non-radial flux of neutrons and non-attainment of thermal equilibrium in the moderator were taken into account. Possible improvements of the method are discussed.

TOTAL CROSS SECTION OF LEAD FOR SLOW NEUTRONS.
See Abstr. 12351

13445 MEASUREMENT OF THERMAL NEUTRON DIFFUSION PARAMETERS IN WATER AND IN SOLID DIPHENYL WITH PULSED NEUTRON SOURCE. A.Ádám, L.Bod and L.Pál.

Acta phys. Hungar., Vol. 13, No. 1, 25-33 (1961).

The diffusion parameters of thermal neutrons were measured in water and in solid diphenyl at room temperature by the pulse method. The results of the measurements in water are consistent within the statistical error with the values known in literature. The diffusion parameters obtained in diphenyl are: $l_0 = 286 \pm 23\ \mu\text{sec}$, $D(T_0) = 42940 + 1800\ \text{cm}^2\ \text{sec}^{-1}$, $L_D = 3.50 \pm 0.18$ cm, $C = 13300 \pm$ $\pm\ 2850\ \text{cm}^4\ \text{sec}^{-1}$ and $\lambda_t = 0.515$ cm.

13446 A WIDE-RANGE NEUTRON DETECTOR AND MONITORING INSTRUMENT.

K.G.A.Porges and T.E.Klippert.
Nuclear Sci. Engng (USA), Vol. 7, No. 2, 147-55 (Feb., 1960).

A boron-lined proportional counter has been developed whose cathode diameter varies continuously, hence varying the gas multiplication along the length of the counter. The sensitive area of the cathode thus becomes a function of the applied voltage, electrical amplification, and pulseheight discrimination. A semi-empirical relationship between counter geometry, gas parameters, and applied voltage is used to develop theoretical expressions for the dependence of count rate on applied voltage and cathode geometry. The behaviour of cathodes of hyperbolic and exponential shape is treated. A prototype exponential counter, operated in a pulse counting mode, was constructed and tested. The approximately logarithmic relationship between neutron flux and voltage predicted for such an instrument was confirmed.

13447 CONSTRUCTION OF A NEUTRON SPECTROMETER.
J.M.Cottier, P.Denis, M.Philippe and D.Roux.
Arch. Sci. (Switzerland), Vol. 13, No. 3, 375-80 (July-Sept., 1960).
In French.

A crystal spectrometer was constructed for slow neutrons from a reactor. By use of the instrument, valuable research can be carried out with a reactor supplying even a weak neutron flux. The theory of the neutron spectrometer is briefly discussed and the construction of the spectrometer, collimator, detector, etc., is described in detail. B.Brown

13448 A FAST CHOPPER AND ITS USE IN THE MEASUREMENT OF NEUTRON SPECTRA.
E.Johansson, E.Lampa and N.G.Sjöstrand.
Ark. Fys. (Sweden), Vol. 18, Paper 36, 513-31 (1960).

The fast chopper installed at the Swedish natural-uranium—heavy-water reactor R1 is described. Its neutron properties as determined from measurements and calculations are discussed. The chopper was used to measure the neutron spectrum in a beam from the central channel of the reactor. The beam was extracted from scatterers of water, heavy water, graphite or lead placed in various positions in the channel. It was found that the thermal spectrum can be fitted accurately to a Maxwell distribution. The epithermal spectrum from lead and graphite scatterers follows the 1/E law within 1% in the region 2-10 eV but deviates from this law at higher energies, probably because of the resonance absorption in uranium. The shape of the function joining the Maxwell and 1/E parts together was studied in detail. The effective starting point of the 1/E spectrum was found to be (3.6 ± 0.4) kT, where T is the neutron temperature. Supplementary measurements with foils and counters showed that the beam spectrum from graphite or lead scatterers is very closely the same as the spectrum in the empty channel. The neutron temperature in the channel was found to be 29 ± 10 deg above the moderator temperature and the epithermal fraction β was obtained as 0.0420 ± 0.0015.

13449 THORIUM FISSION CHAMBER.
F.M.Boreli.
Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 25-6 (March, 1960).

Describes a simple fission chamber for fast neutron flux measurement, using thorium as fission material. The technique for preparing thin thorium films is presented.

13450 CONSTRUCTION AND STUDY OF A BISMUTH FISSION CHAMBER FOR THE DETECTION OF HIGH ENERGY NEUTRONS. L.Kowalski.
J. Phys. Radium (France), Vol. 11, No. 11, 779-82 (Nov., 1960).
In French.

A multiplate chamber which constitutes a threshold detector for neutrons of more than 50 MeV. It is used as a monitor of the Orsay synchrocyclotron neutron beam.

13451 A POSSIBILITY FOR THE MEASUREMENT OF THERMAL NEUTRON FLUX WITH EMULSIONS IN GEL FORM. M.Jurić, W.Winterhalter and M.Đorđević.
Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 27-32 (March, 1960).

Emulsions in gel form loaded with boron, lithium and uranium were used. The results are compared with those obtained with Ilford plates loaded with boron. Errors of measurement are determined and an efficient method for the determination of neutron flux is suggested.

13452 MICROWAVES IN NEW DETECTOR MEASURE THERMAL-NEUTRON FLUX.
P.D.Wickersham and L.T.Ostwald.
Nucleonics (USA), Vol. 19, No. 6, 66, 68-71 (June, 1961).

Ionization produced by neutron reactions in a gas is measured by finding the attenuation of microwaves in a waveguide contain the gas. In an experimental demonstration He^3 gas was used in pyrex container inside a "C" band waveguide to measure neutr fluxes from 10^{10} n/cm^2 to 10^{12} n/cm^2. The performance of the detector was calculated from basic theory, and reasonable agr ment with the experimental results obtained. R.D.

MEASUREMENT OF ABSORBED DOSE OF NEUTRONS. See Abstr. 13233

13453 A HIGH INTENSITY NEUTRON GENERATOR.
S.K.Mukherjee, N.K.Majumder and A.Ganguly.
Indian J. Phys., Vol. 34, No. 7, 307-20 (July, 1960).

A 400 kV deuteron d.c. accelerator of Cockroft—Walton ty for producing neutrons by d—d and d—t reactions, is described Special features and principal operating characteristics are di cussed.

13454 HIGH YIELD GENERATOR OF PULSED 14 MeV NEUTRONS.
J.V.Braddock, T.G.Bullen, B.J.Dunn, D.F.McDonald and H.A.Miranda, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 946-9 (Aug., 1961).

Apparatus for obtaining 14 MeV neutrons in pulses of appr imately 10 μsec duration is described. It employs a gaseous d charge in deuterium at low pressure whereby deuterons of up t 180 keV energy are generated and accelerated into a tritiated zirconium target. This method provides a much greater abund of deuterons than is obtainable with ion guns. In its present fo the device has given yields approaching the theoretically expec value of 10^{10} neutrons per pulse.

13455 NEUTRON-SOURCE CALIBRATIONS: A REVIEW.
E.J.Axton.
Nucleonics (USA), Vol. 19, No. 3, 90, 92, 94 (March, 1961).

Three recent comparisons are included in a table yielding relative values for thirteen sources from eight different countr The overall spread of the ratios is 3.8%. R.D.

13456 DIRECT ELECTRONIC DECAY OF THREE π^0'S EMITTED FROM AN ANTINEUTRON ANNIHILATI STAR. Tsai-Chü and C.Simonin-Haudecoeur.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1102-14 (June 16, 1961).

Continuous search for antineutron annihilation events in a antiproton stack lead to the discovery of a star of 10 + 15$\bar{n}$. Of fifteen shower particles of this star, twelve are identified as electrons and three as pions. A negative pion among the three comes to rest. The ten heavy prongs contain only evaporation protons. All the protons come to rest in the emulsion and eac proton has a kinetic energy less than 15 MeV. Dividing the tw electrons into three groups and assuming each group as the de of $\pi^0 \rightarrow e^+ + e^- + e^+ + e^-$, one can evaluate the masses of the th π^0's respectively as (136 ± 14), (135 ± 14) and (136 ± 13) MeV. probability for the simultaneous decay of three ordinary π^0's i 4×10^{-14}. This event suggests the possibility of a new process the production of electrons, e.g. the existence of a second π^0. Considering the high multiplicity, the wide angular distributio the right average energy of the pions as well as the total energ the star, it is concluded that this event is the result of an anni tion between an antineutron and a nucleon. A small-cell techni proposed for the measurement of the multiple scattering of the inclined minimum-ionizing tracks.

Mesons

13457 THE COMPOSITE MODEL OF MESONS AS A LIMI OF MESON THEORY. Y.Ataka.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 895-900 (June, 196

In meson theory with local interactions the probability amplitudes for bare mesons vanish in the limit of infinite bare coupling constant $g \rightarrow \infty$ and infinite bare meson mass $\mu \rightarrow \infty$, whe g/μ remains finite. Then the probability amplitude for a no m state satisfies the same eigenvalue equation as the composite model with local Fermi interactions, whose coupling constant $G = \frac{1}{2}g^2$. The physical meaning of such a procedure and the re thus obtained are discussed.

RELATION BETWEEN THE BARE AND PHYSICAL MASSES OF VECTOR MESONS. K.Johnson.

Phys. (Internat.), Vol. 25, No. 3, 435-7 (June, 1961).
uming the usual canonical commutation relations to hold, n is found between the bare and the physical masses of iesons, which implies that the physical mass of the photon

MESON PRODUCTION IN NUCLEUS—NUCLEUS COLLISIONS.

nder, J.Avidan, A.Avni and G.Yekutieli.
imento (Italy), Vol. 20, No. 4, 648-61 (May 16, 1961).
leus—nucleus collisions at cosmic-ray energies are d in terms of nucleon—nucleon collisions. The average city for different types of reactions is predicted and d with experimental observation.

RECURRENCE RELATIONS IN ISOSPIN FOR STATISTICAL WEIGHTS. H.Pilkuhn.

imento (Italy), Vol. 21, No. 2, 301-4 (July 16, 1961).
statistical charge probabilities in multiple production es, recurrence relations in isospin are derived. Taken with an explicit formula for isoscalar charge probabilities by Cerulus (Abstr. 5740 of 1961), these relations are the nvenient means for numerical calculations for large particle and low isospin.

ESTIMATE OF THE ROLE OF THE LAW OF CONSERVATION OF ANGULAR MOMENTUM IN THE TICAL THEORY OF PARTICLE PRODUCTION.

novskii and G.I.Kopylov.
er. teor. Fiz. (USSR), Vol. 40, No. 1, 180-2 (Jan., 1961).
an.
shown that the predictions of the statistical theory of meson production remain almost unaltered if the conservahe z-component of the angular momentum is taken into in the simplest classical way. The resulting anisotropy gular distribution of the particles is apparently smaller observed in reality. [English translation in: Soviet -JETP (USA), Vol. 13, No. 1, 125-6 (July, 1961)].

TINUCLEON—NUCLEON ANNIHILATION TO TWO MESONS.

r. 13408

A NOTE ON THE CAPTURE OF NEGATIVE MESONS IN PHOTOGRAPHIC NUCLEAR EMULSIONS. R.D.Hill.

imento Suppl. (Italy), Vol. 19, No. 1, 83-90 (1961).
slowing down of extremely low energy negatively charged is discussed and range-energy curves are obtained. Based curves, an evaluation is made of the relative capture rates ve mesons in light and heavy nuclei of photographic ns. These rates appear to be in very good agreement with ental observations on the capture of negative μ-mesons r emulsions.

ON THE NUCLEAR INTERACTION OF MU-MESONS. H.Shibata.

Soc. Japan, Vol. 16, No. 3, 372-7 (March, 1961).
penetrating showers observed with a large multiplate cloud at 50 m w.e. and 250 m w.e. underground were analysed. quencies of the penetrating showers which are experimentally to be produced by μ-mesons were interpreted by the s—Weiszäcker method and the constant photonuclear crossof 1.4×10^{-28} cm^2 nucleon^{-1}, was determined. It was also at the angular distribution of secondary penetrating particles ple productions produced by μ-mesons is nearly isotropic ntre-of-mass system of the target nucleon and photon which lly associated with the incoming μ-mesons.

MUONIUM—ANTIMUONIUM TRANSITIONS. S.L.Glashow.

imento (Italy), Vol. 20, No. 3, 591-2 (May 1, 1961).
absence of certain processes like $\mu \rightarrow e + e + \bar{e}$ suggests a number $m = \pm 1$ for charged leptons, with the selection rule Muonium—antimuonium transitions would indicate $\Delta m = 4$ s. Theoretical and practical points are discussed.

R.J.N.Phillips

13465 POLARIZATION EFFECTS IN THE SCATTERING OF MUONS ON PROTONS. G.V.Frolov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 296-7 (Jan., 1961).
In Russian.

The polarization of recoil protons and scattered μ-mesons during the scattering of polarized μ-mesons on unpolarized protons is computed by taking into account the proton electromagnetic form factors. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 200 (July, 1961)].

13466 α-PARTICLE WAVE FUNCTIONS AND THE MUON CAPTURE IN ^{4}He. A.Bietti.

Nuovo Cimento (Italy), Vol. 20, No. 5, 1043-5 (June 1, 1961).

Three examples are considered, which suggest that the total muon capture rate is much more sensitive to the r.m.s. radius than to the detailed shape of the He^4 wave-function.

R.J.N.Phillips

13467 CALCULATION OF THE NUCLEAR ABSORPTION OF μ^- MESONS BY O^{16}. E.G.Beltrametti and G.Fiorio.

Nuovo Cimento (Italy), Vol. 21, No. 1, 84-7 (July 1, 1961). In Italian.

A shell model analysis is given for the energy spectrum of the neutrons ejected in μ^- absorption by O^{16}.

13468 THEORY OF THE CAPTURE OF MUONS BY NUCLEI. G.Goulard and B.Goulard.

J. Phys. Radium (France), Vol. 21, No. 5, 452-5 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). A general formula is obtained for the capture probability of a negative muon by a nucleus, using spherical tensors. The non-relativistic approximation is used and the nuclear matrix elements are calculated by an independent particle shell model. The results are applied to the capture probability by some nuclei close to calcium, to evaluate the ratio of Gamow-Teller to Fermi coupling.

13469 FORM FACTOR IN THE DECAY $\pi^0 \rightarrow \gamma + e^+ + e^-$. D.V.Volkov and V.M.Orayevs'kȳi.

Ukrayin.fiz. Zh. (USSR), Vol. 4, No. 6, 804-6 (1959). In Ukrainian.

13470 THE CONTRIBUTION OF THE BORN TERMS TO PHOTOPRODUCTION OF PIONS AT HIGH ENERGIES.

G.Höhler, K.Dietz and A.Müllensiefen.
Nuovo Cimento (Italy), Vol. 21, No. 1, 186-9 (July 1, 1961).

The phenomenological analysis of the reactions $\gamma + p \rightarrow n + \pi^+$ and $\gamma + p \rightarrow p + \pi^0$ at high energies is discussed assuming that the production amplitude can be approximated as the sum of pure multipole transition amplitudes and in the first case an "electric" Born amplitude. The authors claim that further terms should be added, which are expected to contribute not less than the resonance terms.

J.H.Gunn

13471 DOUBLE PION PHOTOPRODUCTION IN THE 1.2-BeV REGION. K.Itabashi.

Phys. Rev. (USA), Vol. 123, No. 6, 2157-9 (Sept. 15, 1961).

Energy and angular distribution of π^--mesons produced by the reaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$, are calculated and the results are compared with the Cal. Tech. measurements at (1230 ± 50) MeV (Abstr. 2093 of 1961). The calculation starts from the static theory for the $(N\pi\gamma)$ system with the source function $v(p) = \xi^2/(\xi^2 + p^2)$, $\xi = 4.7\ \mu$, which is of the form proposed by Fubini and Thirring in their analysis of the low-energy π—N phenomena, and thought of as a substitute for the form factor of the $(NN\pi)$ vertex. The kinematical effects of the nucleon recoil, which is numerically very important, are also taken into account so as to cover, as much as possible, the drawback of the static theory. The contributions from the nucleon core current, $(\gamma - 3\pi)$ vertex, and the final-state $\pi - \pi$ interaction are neglected. The physical reasoning of these approximations is briefly discussed. The results of the calculation agree satisfactorily with the Cal. Tech. data and show that, in this energy region, processes other than Drell's peripheral one (Abstr. 20095 of 1960; 439 of 1961) are still important, as well as the latter.

13472 CHARGE ASYMMETRIES IN THE ANGULAR DISTRIBUTION OF π AND K MESONS FROM ANTIPROTON ANNIHILATION IN FLIGHT.

B.C.Maglić, G.R.Kalfleisch and M.L.Stevenson.
Phys. Rev. Letters (USA), Vol. 7, No. 4, 137-41 (Aug. 15, 1961).

Using the 72 in. Berkeley bubble chamber and an antiproton beam of 1.61 ± 0.04 BeV/c in the laboratory, analyses of the following reactions were made: (i) $\bar{p} + p \to 2\pi^- + 2\pi^+ + \pi^0$ (674 cases) and $p + \bar{p} \to 2\pi^- + 2\pi^+$ (136 cases) gave an excess of π^- in the forward and π^+ in the backward direction. There were angular correlations between the pions influenced by the forward and backward peaks. (ii) $\bar{p} + p \to K + K + n\pi$ (135 events) gave excess of negative K's and π's in the forward direction. J.E.Paton

13473 π-MESON PAIR PRODUCTION BY γ-QUANTA ON NUCLEONS IN A STRONG COUPLING THEORY.

Yu.V.Tsekhmistrenko.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No.1, 35-40 (1958). In Ukrainian.

In the first non-vanishing approximation (Abstr. 4835 of 1956), processes (III) and (V) are allowed, and process (I) is forbidden. The computation is carried out in the second approximation of the perturbation theory. One of the energy terms of the interaction of the meson—nucleon system with the electromagnetic field and the energy of the interaction of a complex nucleon with free mesons are regarded as perturbations. The results of calculating the cross-sections are given by formulae. A comparison with the results obtained by other authors (Abstr. 611 and 5719 of 1953) shows that the effective cross-sections of process (III) at the threshold turn out to be of the same order in all three cases (the constants selected differ, of course, in every case). The cross-section of process (V) in the present paper proves to be of the same order as that of process (III) in contrast to the results of Lawson and Drell (Abstr. 5719 of 1953), in which the cross-section of process (V) is small compared with that of process (III), being of the order of $(\mu/M)^2$. This difference offers still another possibility for experimental verification of the characteristic term, obtained as a result of Foldy's transformation of a Hamiltonian with pseudoscalar coupling.

13474 THE SINGLE PION PRODUCTION PROCESS IN π⁻—p COLLISION AT 1 BeV AND THE SAKATA MODEL.

S.Sawada, T.Ueda and M.Yonezawa.

Progr. theor. Phys. (Japan), Vol. 25, No. 6, 873-7 (June, 1961).

The experimental data of Derado and Schmitz on the single pion production process in π^-—p collision at 1 BeV by the generalized isobar model is analysed. The isobar model is a generalization of the Lindenbaum and Sternheimer 3—3 nucleon isobar model (Abstr. 17403 of 1960). But the standpoint is based on the Sakata model and all the possible fermion and boson states of the full symmetry theory are taken into account. It is shown that this generalized isobar model can well explain the experimental momentum spectra. The evidences of boson isobars of I = 2 with mass ~ 400 MeV and I = 1 with mass ~ 650 MeV are suggested from the analysis of the Derado—Schmitz data.

STATISTICAL TREATMENT OF MULTIPLE PRODUCTION WITH ANGULAR MOMENTUM CONSERVATION. See Abstr. 13319

13475 MEAN FREE PATH OF 4.5 BeV π-MESONS IN ILFORD G5 EMULSIONS.

A.Husain, M.H.Siddiqui and A.Hossain.

Pakistan J. Sci. industr. Res., Vol. 3, No. 1, 21-2 (Jan., 1960).

The value found was 33.5 ± 3.5 cm. Ilford G5 emulsions, 400 μ thick, were exposed to the artificially produced meson beam, the measurements being made by the so-called "line scanning" or "following along the track" method. The result is comparable with earlier data for mesons with energies up to 3 BeV.

13476 STUDY OF INTERACTIONS PRODUCED IN NUCLEAR EMULSIONS BY 300 MeV π-MESONS.

B.Willot-Chemel.

Ann. Phys (France), Vol. 6, No. 5-6, 703-34 (May-June, 1961). In French.

Inelastic scattering, the formation of stars and the production of charged π-mesons were studied. The mean free path for all events is of the order of the geometric mean free path. The absorption stars have a small number of branches and the inelastically scattered π^--mesons suffer a large loss of energy. The ratio between the number of mesons scattered forwards to the number scattered backwards seems to be an increasing function of the energy of the meson and is nearly equal to one-half the ratio found at 750 MeV. The effective differential cross-section for inelastic scattering has a minimum at 75°. The study of the production of π^+-mesons by π^--mesons with energy close to the threshold shows that the π^- after creation of the π^+ is most often absorbed by the target nucleus and this absorption is manifested by the disintegration of the nucleus. It is shown that charge exchange between a proton and a π^--meson is very rare, but the proportion of suc
events increases with the energy of the primary meson.
J.L.R

13477 INTERNAL PAIRS FROM π⁻—PROTON INTERACT AT REST.

H.Kobrak.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1115-32 (June 16, 1961)

7741 examples of internal pair production in pion—proton
interactions at rest were recorded in hydrogen bubble chambe
photographs. These pairs originate in the reaction $\pi^- + p \to n$
$+ e^+ + e^-$ and in the decay $\pi^0 \to \gamma + e^+ + e^-$. These events wer
analysed to find the experimental distribution in the mass of t
pair and another variable related to the energy partition betw
the members of the pair. These distributions are compared v
theory which includes corrections due to nucleon form factors
radiative corrections. The experimental results are in good
ment with this theory. Longitudinal virtual photon contributio
necessary to properly describe the experimental results for r
tive capture pairs and as predicted theoretically are not visib
for π^0 pairs. In accord with present theory, the form factor e
are found to be small for both reactions.

13478 A MODEL FOR K⁰/K⁺ BRANCHING RATIOS FOR PRODUCTION IN HIGH ENERGY π⁻p COLLISIONS

H.Pilkuhn.

Nuovo Cimento (Italy), Vol. 21, No. 1, 190-3 (July 1, 1961).

The reaction $\pi^- + p \to \Sigma^\pm + K + n\pi$ was studied at laborat
pion momenta of 7 and 16 GeV/c, in which a considerable backw
peaking of the Σ (c.m.s.) was found, and in the 16 GeV/c exper
the Σ^+/Σ^- ratio was found to be of the order of 1.8. These tw
features can be explained in terms of graphs, in which only a
boson lines are connected to the baryon line, and the multiple
production is caused by the interaction of the incoming pion w
of the bosons coming from the baryon. The author claims tha
measuring the K^0/K^+ ratio for Σ^- production r_- one can decide
whether the ππ or πK interaction is the important one. For th
interaction, a specific model is suggested and predictions are
obtained not only for r_- but also for r_+ and r_0 (the correspond
K^0/K^+ ratios for Σ^+ and E^0, Λ^0 production). The possible influ
of a Kπ resonance interaction is mentioned. J H

13479 ABOUT THE PION—HYPERON RESONANCE.

P.G.O.Freund, A.M.Longoni and E.Predazzi.

Nuclear Phys. (Internat.), Vol. 25, No. 4, 656-60 (June, 1961).

The spectral function of the Σ-hyperon propagator calcul
with the aid of a method proposed by Redmond under the assu
of odd Σ—Λ relative parity and strong (ΣΛ)π interaction is us
a theoretical derivation of the position and width of the Λ—π r
ance recently discovered by Alvarez et al (Abstr. 3240, 8514
1961). The computed figures are in good agreement with expe
mental data. The same method is applied also for a discussi
the possibility of a high-energy (1, 1) π—N resonance and for
computation of the low-energy (1, 1) cross-section in π—N sc
ing.

13480 APPLICATION OF ρ-MESON THEORY TO 5 BeV DATA.

H.Nakamura.

Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1380-1 (Dec., 196

It is suggested that the anomalous group of recoil proton
two-prong events in the region $1.2 \le p \le 1.4$ BeV/c,
$-1.0 \le \cos\theta \le -0.9$ (p and θ are the c.m.s. momentum and sc
angle) may correspond to production of ρ-mesons via single p
exchange. Taking the form factors from experiment, the tota
cross-section is found to be 1.7-1.9 mb, as compared with th
experimental value of 1.3 mb for 8 events. I.J.R.Ai

13481 PION—NUCLEON INTERACTION AND THE MUL PRODUCTION EXPERIMENT.

H.Ezawa, O.Kamei, K.Mori, H.Shimoida and T.Yoneyama.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 667-83 (April, 19

A method is proposed to investigate the pion—nucleon int
with recourse to the multiple-production experiments at extr
high energy. The method consists of calculating theoretically
characteristics of the collision event with small multiplicity
meson production and comparing the results with the extrapo
from the experimental data for multiple production. The per
tion calculation is performed for the single-pion production p
Although the fit of the result with the extrapolations is not so
factory, it can still be concluded that the pion—nucleon coupli
the pseudo-scalar type is perferable to that of the pseudo-ve
type.

RELATIVISTIC PION—NUCLEON SCATTERING WITH THE DETERMINANTAL METHOD.

C.Garibotti, J.J.Giambiagi and A.Pignotti.
imento (Italy), Vol. 20, No. 6, 1209-11 (June 16, 1961).
perturbation expansion of the scattering amplitude t is
for large values of the coupling constant as in the case of
nteractions. The authors claim that the determinantal
offers the possibility of improving the series for t(ω) once
ed up to a certain order in perturbation theory by using a
ehaved expansion of some quantity r(ω) related to t(ω).
J.H.Gunn

ON THE HIGH ENERGY BEHAVIOUR OF THE PION—NUCLEON ELASTIC SCATTERING AMPLITUDE.

kos.
s. Hungar., Vol. 13, No. 1, 89-97 (1961).
kinematics of the πN elastic scattering is treated in the
ssical approximation. It is shown that if a quasiclassical
sts, then spin-effects become negligible at sufficiently high
rgies, independently of other details of the interaction. An
tic representation of a function defined by means of a Hilbert
m is given. The latter is made use of to derive the
tics of the πN forward scattering amplitude. The possibility
g the results experimentally is discussed.

PION PRODUCTION AND THE HIGHER RESONANCES IN PION—NUCLEON SCATTERING. P.Carruthers.

ys. (USA), Vol. 14, No. 1, 229-304 (July, 1961).
reaction $\pi + N \rightarrow 2\pi + N$ was studied in the vicinity of the
esonances in the pion—nucleon cross-section. The Low
for the production amplitude is transformed into an integral
by isolating the true one-meson intermediate states and dis-
higher order contributions. The only part kept in the in-
eous term corresponds to the collision of a pion in the
cloud with the incident pion in the resonant T = J = 1 state,
simulated by an unstable vector Boson. Crossed terms are
d and the 2π-N state is described by the static model. The
ept in the sum over states describe the rescattering (off the
of one of the outgoing pions. The required off-the-energy-
stic scattering amplitude is approximated by the 3-3 reson-
mula of Chew and Low. With these simplifications the Low
for the production amplitude reduces to an easily soluble
tegral equation. The rescattering amplitude, which domin-
inhomogeneous term in the resonance region, is proportional
3 scattering amplitude of one of the outgoing pions. Although
lt provides some support for the conventional isobar model,
portant to note that the largeness of the rescattering term
rom scattering far off the energy shell, rather than by "real"
n as in the phenomenological isobar model. Quantitative
ons for the $D_{3/2}$ channel leading to a p-wave ($J = \frac{3}{2}$) and an
pion produce a maximum in the cross-section near 600 MeV
pion lab energy. For a π—π resonance energy squared
greement with experiment is obtained with a width about one
t suggested by nucleon electromagnetic structure. In the
approximation, the well-known 600 MeV $D_{3/2}$ isospin $\frac{1}{2}$ reson-
ccurs at the same energy as the 800 MeV $D_{3/2}$ isospin $\frac{3}{2}$
ce. It is assumed, but not proved, that the neglected terms
onsible for the splitting of the resonance energies. When
tting is taken into account, the predicted charge state ratios
second resonance agree well with existing data. The "third"
ce occurs for the state having two p-wave pions, according
resent theory, although no numerical calculations were made
case. This point of view suggests that the $F_{5/2}$, $P_{3/2}$, and
dent channels contribute to the third resonance.

MESON SCATTERING ON NUCLEONS. I.

I.Úlehla.
. Phys., Vol. 10, No. 10, 701-14 (1960).
assumed that nucleons are described by anomalous equa-
particles with spin $\frac{1}{2}$. The π-meson interaction with
is taken in the form of pseudoscalar coupling. Pion
g on the nucleons is calculated in the first approximation
erturbation theory. The cross-sections are dependent on
interaction constants and on one free parameter. The
f the cross-sections is determined for special values of the
on constants and it is shown that by suitable choosing them,
ve agreement with experiment at lower energies can be
.

13486 A POSSIBLE MECHANISM OF THE HIGH ENERGY MAXIMA IN PION—NUCLEON CROSS-SECTIONS.

W.Królikowski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 4, 229-31 (1960).

The motion of the core inside the nucleon is pointed out as a possible reason for the three high-energy maxima observed in π^-—p and π^+—p scattering. A suggestion is made that these peaks are resonances (probably $D_{3/2\,1/2}$, $D_{5/2\,1/2}$, $D_{5/2\,3/2}$) provided by a coupling of the slowly moving core inside the nucleon to the pion field. This possible mechanism of higher excitations of the nucleon would compete with a mechanism via pion—pion interaction suggested previously. J.H.Gunn

13487 A POSSIBLE MECHANISM OF THE $D_{3/2}$, $T = \frac{1}{2}$ RESONANCE IN PION—NUCLEON SCATTERING.

W.Królikowski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 303 (1961).

In previous papers (preceding abstract and Abstr. 17388 of 1960) the author proposed a model which resulted in ascribing $D_{3/2\,1/2}$, $D_{5/2\,1/2}$, etc. for the second, third, etc. resonances in the cross-section of π^-—p scattering. It is now shown that the second resonance is in fact a $D_{3/2\,1/2}$ state, but that the third is probably a $F_{5/2\,1/2}$ state. The author shows, by the investigation of the signs of his parameters, that the existence of the $D_{3/2\,1/2}$ resonance and the simultaneous absence of any other D resonance is not inconsistent with his model. C.Wilkin

13488 MODIFICATION OF THE CHEW—LOW FORMULA FOR THE $(\frac{3}{2},\frac{3}{2})$ π—N RESONANCE. W.M.Layson.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1207-8 (June 16, 1961).

Inserting a more "relativistic" nucleon source of approximately nucleonic dimensions brings about better agreement between theory and experiment to much higher energies. J.H.Gunn

13489 THE EFFECT OF PION—PION INTERACTION ON THE PION—NUCLEON SMALL P-WAVE PHASE SHIFTS.

K.Ishida.

Progr. theor. Phys. (Japan), Vol. 25, No. 2, 294-6 (Feb., 1961).

Argues that S- and P-wave ππ interactions can explain the behaviour of all the small P-wave πN phase shifts. R.J.N.Phillips

13490 THE EFFECT OF THE PION—PION INTERACTION ON THE PION—NUCLEON SCATTERING. K.Ishida.

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 797-802 (May, 1961).

It is suggested that the low-energy pion—nucleon phase shifts will be well understood by taking account of the effects of not only the pion—pion P-wave interaction but also the pion—pion S-wave interaction into the equations for the p-wave scattering amplitudes derived by Chew, Goldberger, Low and Nambu (Abstr. 7428 of 1957).

13491 DISPERSION RELATIONS FOR VIRTUAL PION-NUCLEON SCATTERING. J.Iizuka and A.Klein.

Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1017-27 (June, 1961).

In connection with a proposed calculation of single pion production in nucleon—nucleon collisions, the process of pion—nucleon scattering in which the incoming pion is virtual is investigated by means of the dispersion theoretic method developed by Chew, Goldberger, Low and Nambu (Abstr. 7428 of 1957). The static limit is studied in detail and the Chew—Low amplitude for virtual scattering is shown to result for small virtual pion masses. More generally, it is proposed that the Blankenbecler—Gartenhaus solution (Abstr. 2556 of 1960), which is recorded, may provide a useful approach in applications in which large virtual pion masses play an essential role.

13492 INTEGRAL EQUATION FOR PION—NUCLEON SCATTERING AT LOW ENERGIES. Chou Hung-Yüan.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 227-36 (Jan., 1961). In Russian.

A set of coupled integral equations for the S and P pion—nucleon scattering-wave amplitudes at small energies is deduced on basis of the dispersion relations for forward and backward scattering and the unitarity conditon. The contribution of the cut in the nonphysical region is taken into account without applying the analytic continuation by the Legendre expansion. The integral equations include $N\bar{N}$-annihilation amplitudes, which are explicitly connected with the presence of the ππ-interaction. [English translation in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 156-62 (July, 1961)].

13493 P-WAVE RESONANCE IN PION—PION SCATTERING.

M.Yamazaki.

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 727-34 (May, 1961).

Pion—pion scattering in the $I = l = 1$ state is treated by the Tamm—Dancoff method. By making an approximation in which configurations containing up to three particles of meson and nucleon pair type are taken into account in the 4th order pion—pion interaction kernel, the existence of resonance is concluded. By adjusting the coupling constant $g^2/4\pi$ between pion and nucleon so as to fit the pion—pion scattering length $a = 0.1$—$0.3\,\mu^{-3}$ in the $I = l = 1$ state, a resonance level of 600—400 MeV is found and a resonance width of 140—40 MeV which is quite consistent with that adopted by Takeda et al. in their theory of the 2nd-3rd maximum in pion—nucleon scattering (Abstr. 1625 of 1956) and also by Erazer—Fulco in the explanation of the isotopic vector magnetic form factor of a nucleon (Abstr. 7341 of 1960). The value $g^2/4\pi = 6.1$-6.8 is adopted which is somewhat smaller than the conventional one. This small coupling constant is interpreted as due to the inclusion of the effects of scattering and annihilation of a virtual nucleon pair.

13494 POSSIBILITY OF A 4-PION STRUCTURE IN THE T = J = 1 PION—PION SCATTERING AMPLITUDE.

V.De Alfaro and B.Vitale.

Phys. Rev. Letters (USA), Vol. 7, No. 2, 72-4 (July 15, 1961).

It is postulated that the lack of quantitative agreement about the location and width of the $T = J = 1$ pion—pion resonance is due to there being in fact two resonances: A "bi-pion" and a "four-pion". Using the projection theorem of low-energy nuclear physics, an approximate expression is obtained for the mass of the "four-pion" in terms of the masses of the "three-pion" and "bi-pion" resonances. It is deduced from this that the structure of the $T = J = 1$ resonance may be directly observable in the production experiments of Abashian et al. at higher energies. C.Wilkin

13495 REMARKS ON THE NUCLEAR ABSORPTION OF NEGATIVE PIONS IN DEUTERIUM.

E.G.Beltrametti.

Nuovo Cimento (Italy), Vol. 21, No. 1, 98-106 (July 1, 1961).

The correlation between the polarization of the neutrons emitted in the capture reaction $\pi^- + d \rightarrow 2n$ is examined. It is found to be simply related to the state of the absorbed pion, providing a means of separating the contributions to the process from s and p states of the meson. A possible extension to the capture in complex nuclei is briefly sketched.

13496 THE DECAY MODES AND LIFETIME OF NEGATIVE K-MESONS.

B.Bhowmik, P.C.Jain and P.C.Mathur.

Nuovo Cimento (Italy), Vol. 20, No. 5, 857-77 (June 1, 1961).

Two emulsion stacks, exposed to magnetically analysed enriched K^--meson beam of average momentum 430 MeV/c and 440 MeV/c from the Bevatron, were used to estimate the relative abundance and lifetime of K^--mesons. While following 103 m of track length, 48 decay-like events were observed. From the analysis of events with good geometry the following decay modes were established: $K_{\mu 2}$, $K_{\pi 2}$, $K_{\mu 3}$, $K_{\pi 3}(\tau')$ and K_β. No example of τ^--decay was found in the line scan sample, but the mode was established from an area scan event. No knowledge of K^+-decay modes, or of the mass of the primary particle was assumed in the analysis. The mean mass, obtained from the decay kinematics of $K_{\mu 2}$ and $K_{\pi 2}$ mode, is $(965.8^{+16.5}_{-21.5})\ m_e$. The mass value from τ^--decay mode is found to be $(964.45 \pm 2.91)\ m_e$. The percentages of various decay modes are as follows: $K_{\mu 2}$ (56.0 ± 12.8), $K_{\pi 2}$ (33.4 ± 8.7), $K_{\mu 3}$ (5.9 ± 3.1), $K_{\pi 3}(\tau')$ (2.7 ± 2.8), $K_{\beta 3}$ (2.9 ± 1.9) and τ^- $(0 + 2.0)$. The mean lifetime was determined after detailed considerations of the contamination due to decay-like clean interactions, and losses due to missing secondaries. The mean lifetime is $(1.27^{+0.36}_{-0.23}) \times 10^{-8}$ sec.

13497 A NOTE ON THE FINAL STATE INTERACTION IN $K^+_{2\pi}$ DECAY.

K.Kawarabayashi.

Nuovo Cimento (Italy), Vol. 20, No. 5, 1030-4 (June 1, 1961).

From a field theoretic estimate of the final-state interaction using the dispersion relation technique, the author suggests evidence against the possible explanation of $K^+_{2\pi}$ decay of Good and Holladay (Abstr. 7413 of 1960) who assume that the decay is through a strict $I = \frac{1}{2}$ weak interaction, modified by radiative corrections, with an enhancement by a strong pion—pion interaction in the state of $I = 2$ and $J = 0$. An alternative possibility for the explanation of the $K^+_{2\pi}$ decay rate is put forward. J.H.Gunn

13498 VERY PRELIMINARY EVIDENCE FOR EVEN KΣ PARITY FROM ASSOCIATED PHOTOPRODUCTIC

J.J.Sakurai.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1212-16 (June 16, 1961)

The angular distribution of associated photoproduction
$\gamma + p \rightarrow K^+ + \Sigma^0$ is discussed. On the assumption that beside
one-K-exchange pole term only s-waves and sp-interference
significant, even KΣ parity is deduced and the scalar kΣN co
constant of the order of 0.6 obtained. F.

13499 S- AND P-WAVE INTERACTIONS OF K^- MESONS HYDROGEN.

P.Nordin, Jr.

Phys. Rev. (USA), Vol. 123, No. 6, 2168-76 (Sept. 15, 1961).

Low-energy K^--meson interactions in a hydrogen bubble
chamber were studied and the energy range extended to a regi
that involves P-waves. Scattering and hyperon-production cr
sections were measured at mean K^--meson laboratory momen
of 300 MeV/c and 400 MeV/c. Elastic-scattering angular dist
tions were obtained and, along with the values of the cross-sec
indicated the presence of P-waves. Based on 289 observed dec
the measured K^--meson mean lifetime is $(1.31 \pm 0.08) \times 10^{-8}$

13500 K^- ABSORPTION IN ^{4}He. I. THE HYPERON—PIC RESONANCE.

M.M.Block, E.B.Brucker, R.Gessaroli, T.Kikuchi, A.Kovacs,
C.M.Meltzer, R.Kraemer, M.Nussbaum, A.Pevsner, P.Schlein
R.Strand, H.O.Cohn, E.M.Harth, J.Leitner, L.Lendinara, L.Mo
and G.Puppi.

Nuovo Cimento (Italy), Vol. 20, No. 4, 724-32 (May 16, 1961).

Results are given on a hyperon—pion resonance. This
resonance was investigated in the absorption of K^--mesons in
The experiment was performed, using the Duke Helium Bubble
Chamber. Tentative assignments of spin, parity and level wid
the Y* state are given.

13501 ON SOME CONSEQUENCES OF CHARGE INDEPEN DENCE FOR K^+—NUCLEON INTERACTIONS.

V.de Santis.

Nuovo Cimento (Italy), Vol. 20, No. 5, 983-1000 (June 1, 1961).

An attempt is made to find consistent relations between th
three K^+—N cross-sections assuming the validity of charge inc
dence. It is seen that, in this spirit, the K^+—n elastic cross-s
should be much greater than previously deduced from counter
emulsion experiments. These experiments are then analysed
the possibility of increasing the value deduced from them for t
cross-section, bringing it in the limits required by charge inde
dence, is shown to be consistent with reasonable changes of th
parameters of the nuclear model used in the analysis of this in
action. Finally, a Tamm—Dancoff calculation in terms of pseu
scalar KNY coupling, taking into account the recoils, is made;
somewhat good fit with the experimental data is found, with va
of the two coupling constants g_Σ and g_Λ of the same order of
magnitude as the π—N one.

13502 PION—HYPERON RESONANCE FROM $\bar{K}$ NUCLEO COULOMB CONSTRUCTIVE S-WAVE PARAMETE

G.Costa, F.Ferrari and M.Pusterla.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1224-7 (June 16, 1961).

It is shown that a Coulomb constructive $\bar{K}$—N scattering
amplitude can generate a resonance in the $I = 1$, S-wave amplit
of the pion—hyperon system, if the long range force (due to the
$K\bar{K}$—$\pi\pi$ interaction) is taken into account. A quantitative estim
of this resonance in terms of recent values for the pion system
and in terms of the latest K^-N and K^+N scattering data is in
progress. C.V

13503 SOME REMARKS ON GLOBAL SYMMETRY.

W.Królikowski.

Nuclear Phys. (Internat.), Vol. 26, No. 1, 91-6 (July, 1961).

According to Gell-Mann's original idea of global symmetr
K-meson interactions violate this symmetry. In the present p
a speculative argument is described suggesting that all K-mes
interactions must break down global symmetry and even restr
global symmetry (RGS). There exists, however, a kind of gene
ized RGS, for which this violation of RGS is more manifest in
real K-meson processes than in the virtual ones. The argume
presented connects the problem of RGS and its violation with t
question why leptons do not interact strongly with pions and
K-mesons.

04 KK$\pi\pi$ -INTERACTION AND NUCLEON CORE.
S.Minami.

heor. Phys. (Japan), Vol. 25, No. 4, 646-52 (April, 1961).
e contribution from the K-meson cloud to s-wave pion—
n scattering is estimated under the assumption that there
a strong KK$\pi\pi$ -interaction. The effect of this interaction on
nergy phenomena is discussed.

05 ON THE SCATTERING OF K^+ BY NUCLEON AT LOW ENERGIES.
M.Azuma and T.Ebata.

theor. Phys. (Japan), Vol. 26, No. 6, 1369-71 (Dec., 1960).
tal cross-sections from 0 to 30 MeV for $K^+ + p \to K^+ + p$,
$\to K^0 + p$, $K^+ + n \to K^+ + n$, and the differential cross-
at 225 MeV for $K^+ + p \to K^+ + p$, are calculated in second-
perturbation theory, assuming a ps-ps K—baryon coupling.
ta, which indicate a strong s-wave interaction in all reactions,
ted reasonably well, and it is suggested that this may be
the long range of the s-wave interaction. I.J.R.Aitchison

6 DISPERSION RELATIONS FOR KAON—NUCLEON SCATTERING AND KK$\pi\pi$ INTERACTION.
K.Igi.

theor. Phys. (Japan), Vol. 25, No. 5, 753-79 (May, 1961).
general formalism is given in order to investigate the type of
-Λ nucleon couplings together with the KK$\pi\pi$ interaction by
g the Cini—Fubini approximation to the Mandelstam repre-
on for the K-nucleon scattering (Abstr. 15276 of 1960). By
suitable combinations of invariant amplitudes for $K^{\pm}$—p and
the effects due to the isopin independent and dependent type
KK$\pi\pi$ interaction were isolated. Necessary experimental
ich makes the independent determination of these coupling
f possible are suggested. A simple method which allows
ermination of the isopin dependent KK$\pi\pi$ interaction is
sed a suitable experiment for it is proposed.

7 INTEGRAL EQUATIONS FOR KN SCATTERING.
J.Wolf and W.Zoellner.

sper. teor. Fiz. (USSR), Vol. 40, No. 1, 163-9 (Jan., 1961).
sian.
egral equations for KN and $\bar{K}N$ scattering in low angular
tum states are derived in the Mandelstam representation on
is of dispersion relations for forward and backward scatter-
n approximation is used in which the equations for KN and
ttering are uncoupled. An estimate of the contribution of
wave is given in terms of the s- and p-wave amplitudes.
h translation in: Soviet Physics-JETP (USA), Vol. 13, No. 1,
(July, 1961)].

8 K^+—PROTON SCATTERING IN A CASE OF SCALAR COUPLING.
M.Święcki and M.Szalek.

cad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8,
-12, 807-10 (1960).
—p scattering is calculated in lowest order Tamm—Dancoff
imation, assuming scalar NKΛ and NKΣ couplings. The re-
o not agree with experiment. R.J.N.Phillips

09 OPTICAL MODEL POTENTIAL FOR K^- MESON—NUCLEUS SCATTERING.
A.D.Martin.

Cimento (Italy), Vol. 21, No. 1, 88-97 (July 1, 1961).
e two-body scattering lengths, which describe the interaction
n K^--mesons and free nucleons are used to calculate an
model potential representing the interaction between K^--
s and nuclei. The cross-sections for the scattering of
sons by emulsion nuclei are calculated numerically from this
al and are found to conform closely with the experimental

10 THREE-BODY FINAL STATES FROM K^- CAPTURE IN HELIUM AND DEUTERIUM.
M.M.Block.

Cimento (Italy), Vol. 20, No. 4, 715-23 (May 16, 1961).
npulse-model calculations are made for interactions at rest
mesons in He^4 and D. With the assumptions of non-inter-
emergent particles, momentum spectra are calculated for
ctions:

$$\begin{aligned} K^- + He^4 &\to \Lambda^0 + \pi^- + He^3 \\ &\to \Sigma^{\pm} + \pi^{\mp} + H^3 \\ K^- + D &\to \Lambda^0 + \pi^- + p \\ &\to \Sigma^{\pm} + \pi^{\mp} + n. \end{aligned}$$

Hyperons

13511 THE $\Sigma-\Lambda$ RELATIVE PARITY AND THE $\bar{K}-N$ REACTION. II.
Y.Nogami.

Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1028-34 (June, 1961).

For previous Pt, see Abstr. 17424 of 1960. According to Dalitz and Tuan's phenomenological analysis of K^-—p reactions (Abstr. 379 of 1960) the recently discovered $\pi-\Lambda$ resonance may be interpreted as caused by the existence of a quasi-bound state of $\bar{K}$—N which decays into $\pi-\Lambda$. Granting this interpretation and considering dispersion relations together with experimental information, it is conjectured that the K—Λ (K—Σ) parity relative to N is odd (even) and hence the $\Sigma-\Lambda$ relative parity is odd. Arguments for the conjecture are given concerning branching ratios of the decay of the quasi-bound state and also of the hyperon production in the K^-—p absorption near the threshold.

13512 PHOTON DECAY OF HYPERONS.
P.Prakash and A.H.Zimerman.

An. Acad. Brasil. Cienc., Vol. 33, No.1, 1-12 (1961).

Weak photon decay in which the initial hyperon decays into a baryon and a photon is examined. The lowest order perturbation theory estimates on the three parameters required to describe the angular distribution of the decay products are made, assuming weak derivative coupling (vector minus axial vector) for the hyperon—nucleon—pion interaction together with the $|\Delta I| = \frac{1}{2}$ rule in isotopic spin space. The theoretical rate of decay seems to be an order of magnitude higher than the experimentally observed rate.
C.Wilkin

13513 ON WEAK PION INTERACTION IN NON-LEPTONIC HYPERON DECAYS.
W.Królikowski.

Nuovo Cimento (Italy), Vol. 20, No. 4, 797-802 (May 16, 1961).

It is shown that isotopic and parity properties of non-leptonic hyperon decays can be explained qualitatively by a weak pion—baryon interaction, in which: (i) pions are coupled to matrices describing fundamental (or doublet) and strange isospins of baryons; (ii) all isospin matrices are multiplied by a strangeness-changing neutral matrix; (iii) the fundamental isospin matrices are multiplied by γ_5, whereas the strange ones are not. It follows form (i) and (ii) that this interaction satisfies automatically the rule $|\Delta T| = \frac{1}{2}$ and also the Pais' rule $|\Delta I| = 0$ or 1. The hypothetic connection (iii) between τ matrices and γ_5 may be significant for understanding the mutual relations of strong and weak pion interactions. It gives the "parity clash" discussed by Pais.

13514 ISOTOPIC INVARIANCE IN PROCESSES INVOLVING ANTIHYPERONS.
V.A.Lyul'ka.

Zh. eksper.teor. Fiz. (USSR), Vol. 40, No. 1, 256-61 (Jan., 1961).
In Russian.

A number of relations between the cross-sections for reactions involving antihyperons is derived on basis of the isotopic invariance hypothesis. Some additional relations between the cross-sections arise if interaction of π and K mesons with baryons predominates in states with definite isotopic spin values. [English translation in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 176-8 (July, 1961)].

13515 DOUBLE HYPERFRAGMENTS AND RELATIVE PARITY OF Λ AND Σ HYPERONS.
S.Iwao.

Nuclear Phys. (Internat.), Vol. 26, No. 1, 1-9 (July, 1961).

A method for the determination of the relative parity of Λ and Σ hyperons is proposed. The possible bound states of the double hyperfragments are predicted from the parameters obtained before. If the $\Lambda-\Lambda$ interaction is attractive in the singlet S state, Λ and Σ will have the same parity, otherwise the opposite parity.

13516 EXCITED STATE IN $\Lambda-\pi$ SYSTEM AND K^-—p COLLISION.
S.Minami.

Progr. theor. Phys. (Japan), Vol. 25, No. 2, 292-4 (Feb., 1961).

Shows that the strength of low-energy $K^- + p$ reactions cannot be regarded as mainly due to the existence of Λ^*.
R.J.N.Phillips

13517 AN INVESTIGATION OF POSSIBLE BOUND Σ-HYPERON—NUCLEON SYSTEMS AND THEIR DECAY.
A.K.Common.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1133-47 (June 16, 1961).

The binding of Σ-hyperons to nucleons is investigated using potentials suggested by field theory. Special attention is paid to the possibility that the Σ^--hyperon can bind to a neutron while the Σ^+-hyperon and proton are unbound. Tables are given showing the effect of changes in the coupling constants. The lifetime of this hypothetical bound (Σ^-, n) system is calculated, and it is shown that, for certain forms of the weak Hamiltonian responsible for the decay, the interaction in the final state between the two nucleons can be neglected. It is also found that the effect of the Pauli principle in the final state is appreciable even if the (Σ^-, n) system is assumed to have a binding energy less than 1 MeV.

13518 SEARCH FOR LEPTONIC AND RADIATIVE DECAYS OF CHARGED Σ-HYPERONS.

G.Quareni, A.Quareni Vignudelli, K.Gottstein, I.Laboragine and A.Salandin.
Nuovo Cimento (Italy), Vol. 21, No. 1, 177-81 (July 1, 1961).

No leptonic decays were observed in a large sample of charged Σ-hyperons (about 600 $\Sigma^\pm \to \pi^\pm + n$). Taking into account the efficiency of the method which was used for the analysis of the events, the ratio $(e^+ + \nu + n)$ $(\pi^+ + n)$ is less than 1%, in accord with other authors. No $\Sigma^+ \to \pi^+ + \gamma + n$ events, with π^+ of energy less than 75 MeV, were detected. Up to now only two examples have been reported in the literature. Then the ratio $(\pi^+ + \gamma + n)/(\pi^+ + n)$ lies probably between 1 and 2%, consistent with the theoretical predictions.

13519 ELECTROMAGNETIC VERTEX FOR $\Sigma^0 \to \Lambda^0 + \gamma$.

H.Katsumori.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1371-3 (Dec., 1960).

The coefficient of the Pauli-moment-like part of the $\Sigma^0 \to \Lambda^0 + \gamma$ vertex is estimated to be of the order of a few hyperon magnetons; this value does not contradict the standard deviation of the latest measurements of the Σ^0 mass. I.J.R.Aitchison

13520 ELECTROMAGNETIC MASS SHIFT OF Σ HYPERONS.

H.Katsumori.
Progr. theor. Phys. (Japan), Vol. 25, No. 1, 159-61 (Jan., 1961).

Using previously derived vertex relations (see preceding abstract) it is shown that to order e^2 in the hyperon self-energies the mass of Σ^0 is approximately equal to the average of the masses of the Σ^+ and Σ^-. J.E.Paton

13521 ON THE EMISSION OF FAST Σ-HYPERONS FROM DISINTEGRATIONS DUE TO THE CAPTURE OF K⁻-MESONS BY LIGHT NUCLEI.

D.Evans, B.D.Jones, B.Sanjeevaiah, J.Zakrzewski, M.J.Beniston, V.A.Bull and D.H.Davis.
Proc. Roy. Soc. A (GB), Vol. 262, 73-83 (June 13, 1961).

A study was made of those disintegrations produced in photographic emulsion by the nuclear capture at rest of K^--mesons, from which fast charged Σ-hyperons are emitted. In a sample of 63 events, six were analysed unambiguously as being due to absorption in carbon, nitrogen or oxygen without the emission of any neutrons. An additional eight were found to be consistent with capture by a light nucleus with the emission of one neutron only in each case. The fraction of disintegrations due to K^--meson capture in light nuclei from which a fast charged Σ-hyperon is emitted is estimated.

LEPTONIC DECAYS OF STRANGE PARTICLES.

See Abstr. 13370

13522 Y* AND K* IN STRONG INTERACTIONS.

J.Franklin and S.F.Tuan.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1024-9 (June 1, 1961).

Y*, K* are discussed as poles in the unphysical regions of $\bar{K}N$ and $\bar{\Lambda}N$ dispersion relations. The parameters of Y* agree reasonably with the (a–) scattering length fit. J.E.Paton

Deuterons

13523 STUDENTS METHOD FOR DETERMINING THE BINDING ENERGY OF THE DEUTERON.

E.Ortiz.
Amer. J. Phys., Vol. 29, No. 10, 684-6 (Oct., 1961).

A recording spectrometer model 1820 manufactured by Nuclear Chicago with a sodium iodide crystal scintillator, a neutron source, water, and paraffin are used to determine the binding energy of H^2 by measuring the energy of the photons emitted when thermal neutrons are captured by H^1.

13524 PRODUCTION AND DETECTION OF AN ACCELER ED BEAM OF COMPLETELY POLARISED DEUTER

C.W.Drake, D.C.Bonar, R.D.Headrick and V.W.Hughes.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 995-6 (Aug., 1961).

A beam of completely polarised deuterons was obtained usi
the atomic beam magnetic resonance method to select deuteriu
atoms in a single magnetic hyperfine structure state. Atoms in
state (F,m) = (3/2, - 3/2) yielded a beam with 100% polarisatio
the beam current being about 2×10^{-11} amp with an unpolarised
background beam of D_2^+ ions of about 2×10^{-10} amp.

S.J.St-Lo

13525 ON THE DEUTERON AS A FREE NUCLEON TARG AT 145 MeV.

A.F.Kuckes, R.Wilson and P.F.Cooper, Jr.
Ann. Phys. (USA), Vol. 15, No. 2, 193-222 (Aug., 1961).

The quasielastic p—p scattering in the deuteron was studie
145 MeV. Cross-sections and asymmetries in a polarized beam
were measured. No deviation was found from the simple impul
approximation predictions for the asymmetries. For the cross
section, deviations of up to a factor of two were found for cases
where the struck particle had a large momentum before collisi
It is shown that the extrapolation procedure suggested by Chew
Low (Abstr. 7241 of 1959) can be qualitatively used to relate the
results. The use of the extrapolation procedure in other simila
cases is discussed.

13526 INTEGRATED CROSS SECTION FOR A VELOCITY- DEPENDENT POTENTIAL.

O.Rojo and J.S.Leving
Phys. Rev. (USA), Vol. 123, No. 6, 2177-9 (Sept. 15, 1961).

A possible distinction between a velocity-dependent two-
nucleon potential, and a static potential with an infinite repulsiv
core, is sought in their contributions to the integrated cross-se
(σ_{int}) for the deuteron photoeffect. Both potentials considered a
central, with square shapes, and have Serber mixtures for the
attractive parts. (They have Wigner character for the repulsive
core, and for the velocity-dependent term, respectively). These
potentials are adjusted to give (1) the observed binding energy o
the deuteron; (2) the same effective range $\rho(-\epsilon, -\epsilon) = 1.76$ ferr
and (3) the same value (260 MeV) at which the ^3S phase shift
changes sign. Using sum-rule calculations, in the electric-dipo
approximation, it is found that σ_{int} for the static case is
37.7 MeV mb, while for the velocity-dependent case it is very
nearly the same: namely, 38.8 MeV mb.

13527 THE PRODUCTION AND DETECTION OF POLARIZ DEUTERONS.

R.Barloutaud, H.Faraggi, L.Rosen and S.M.Shafroth.
J. Phys. Radium (France), Vol. 21, No. 5, 369-72 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Greno
1960 (see Abstr. 12029 of 1961). The problem of producing a
deuteron beam with pure vector polarization and of detecting thi
polarization is approached from two directions. In one experim
the polarized deuterons are generated by means of the $Be^9(p,d)$
pick-up reaction. In the second experiment 3.4 MeV alpha-part
scatter deuterons through 145° in the c.m. system. In both exper
the polarization produced is revealed by a left—right asymmetr
the reaction $C^{12}(d,p)C^{13}$, which is known to give rise to polarize
protons when the deuterons are unpolarized. Each of the experi
indicates significant deuteron polarization.

13528 DETERMINATION OF DEUTERON POLARIZATION AFTER A NUCLEAR REACTION.

J.Raynal.
J. Phys. Radium (France), Vol. 21, No. 5, 373 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Greno
1960 (see Abstr. 12029 of 1961). After a reaction producing deu
in which the incident beam and target are not polarized, the po
tion of the deuterons is described by four parameters. Two rel
between them are obtained using a reaction whose inverse gives
known polarization, by measuring the ratios of particles going
right, to the left and at right-angles with respect to the initial r
tion. Using a different geometry, another known reaction, or r
the spin of the deuterons with a magnetic field, two more relati
are obtained and the four parameters can be determined.

13529 NOTE ON THE D(γ, p)n REACTION AT THE γ-RAY ENERGY OF 164 MeV.

M.Matsumoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1376-8 (Dec., 1960).

The differential cross-section $d\sigma/d\Omega$ and proton polarizati en computed. The retardation effect R and the conventional tion C are compared: R gives a larger total cross-section C, though its contribution to σ_T for E2 and spin flip M1 ons is smaller than that of C; $d\sigma/d\Omega$ is similar for both C. σ_T and $d\sigma/d\Omega$ as calculated do not agree with experi- eing too small; the inclusion of the virtual meson effect is ed as a remedy. The non-asymptotic part of the final state nction for the two nucleons is found to be important; the l—Thaler 310 MeV or Stapp No. 1 phase shifts gave the cross-section. I.J.R.Aitchison

a-particles

0 SCATTERING OF ALPHA PARTICLES.
R.M.Eisberg and C.E.Porter.
od. Phys. (USA), Vol. 33, No. 2, 190-230 (April, 1961).

e scattering of alpha-particles is reviewed beginning with the xperimental and theoretical work of Rutherford, Geiger and n. Various models of scattering are discussed ranging from hiezer—Pomeranchuk—Blair model to the optical model s, and it is concluded that while much has been learned about structure from alpha-particle scattering there is room for work, particularly in compiling data on total reaction cross- s. B.Brown

He^3—ALPHA SCATTERING.
R.Chiba, H.E.Conzett, H.Morinaga, N.Mutsuro, K.Shoda Kimura.
. Soc. Japan, Vol. 16, No. 6, 1077-85 (June, 1961).

fferential cross-sections for scattering of He^4 by He^3 were ed at E_α = 27.7, 28.5, 29.4, 30.0, 32.0, 33.4, 34.7, 36.5, d 41.0 MeV using a scintillation counter spectrometer, at of mass angles from ~30° to ~150°. Three distinct minima und at about 45°, 100°, and 140°. The absolute cross-section pattern of the angular distribution showed no appreciable in the energy range investigated: thus, there was found no esonance in the $He^3 + He^4$ system corresponding to an state of Be^7 between 13.4 and 19.9 MeV. Differential cross- s of the protons from $He^3(\alpha, p)Li^6$ Li^{6*} were observed. ntial cross-sections of alpha—alpha scattering were also ed at E_α = 33.5 and 35.5 MeV.

2 PHASE SHIFT CALCULATIONS ON $\alpha-\alpha$ SCATTERING.
E.W.Schmid and K.Wildermuth.
Phys. (Internat.), Vol. 26, No. 3, 463-8 (Aug., 1961).

e $\alpha-\alpha$ scattering phase shifts are calculated with two forces which describe the low energy two-nucleon scatter- . The obtained results are discussed.

3 THE INCLINED SOURCE IN THE PERMANENT MAGNET SPECTROMETER.
ć and M.S.Mlađenović.
st. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 175-6 , 1960).

ooster (1927) has shown that the resolution of flat types of ic spectrographs used to measure alpha and beta ray spectra eased if the source makes an angle with the photographic The authors show the increase in resolution obtained by g the source by measurements of the conversion lines of J.L.Redding

4 THE CsI (Tl) SCINTILLATION α SPECTROMETER.
J.Fleury, P.Perrin, M.Boge and J.Laugier.
. Radium (France), Vol. 21, No. 5, 480-3 (May, 1960).
ch.

w and Mean Energy Nuclear Physics Colloquium, Grenoble, ee Abstr. 12029 of 1961). It was observed that the time t is 0.7 μsec for γ-rays and electrons, and 0.40 and 0.72 r α-particles. The luminous efficiency for electrons is per photoelectron (0.4 keV with NaI). The limiting resolu- the α-spectrometry is 2.5%, with 9 MeV α-particles.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

13535 COUNTING RATES OF WIDE-APERTURE COSMIC RAY COUNTER TELESCOPES. D.Stern.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 153-8 (1960).

The wide-aperture cosmic-ray telescope combines a high counting rate with sensitivity to the angular distribution of the particles passing it. Therefore, a wide aperture counter set-up may be used to determine angular distributions where total rates are low (i.e. underground) or to monitor fluctuations affecting angular distributions, where statistical accuracy demands high counting rates. In this paper, a general method for computing the counting rate of rectangular telescopes for $\cos^p\theta$ angular distributions is developed, and actual computation is carried out in some cases. An experiment embodying the above principles, in which the angular distribution of muons underground was investigated, is also described.

13536 MEASURING THE RESOLVING TIME OF HODOSCOPES. G.B.Khristiansen.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 48 (Jan.-Feb.).
In Russian.

Short theoretical discussion of a simple method for measuring the mean resolving time of a multichannel hodoscope as well as that of the individual channels. The time required for the measurements is fairly short: ~100 sec in a typical example using a thyratron to form the master pulses. [English translation in: Instrum. exper. Tech. (USA), No. 1, 50-1 (Jan.-Feb., 1958; publ. April, 1959)]. I.C.Demetsopoullos

13537 SEMI-CUBICAL G.M. COUNTER TELESCOPE SYSTEM FOR UNDERGROUND REGISTRATION OF THE MESON INTENSITY OF THE COSMIC RADIATION.
T.Sandor, A.Somogyi and F.Telbisz.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 209-14 (1960).

A semi-cubical telescope system is described which was built for the registration of the high-energy meson component of the cosmic radiation. A method elaborated to check the stability is applied to the data obtained during the period March 1958 to February 1959.

13538 MULTICHANNEL TRANSISTORIZED APPARATUS FOR DATA RECORDING.
D.Brini, A.Gandolfi and G.L.Tabellini.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 259-67 (1960).

The apparatus was planned to record continuously data, relative to fixed measurement periods, from various counting channels. In particular, this device will be used in conjunction with a cosmic-ray station to detect short period intensity variations. There are 24 counting channels and the data recorded for each channel are 2880 per day, 30 sec being the measurement period. The maximum capacity for each datum is about 100 000 counts. Records are made on photographic film. This method is of low cost, has small volume and offers the possibility of visual and automatic reading and elaboration of data. The apparatus has an independent power supply.

13539 A CLOUD CHAMBER STUDY OF HIGH ENERGY NUCLEAR INTERACTIONS OF COSMIC RAY PARTICLES. I. A POSSIBLE EVIDENCE OF SUCCESSIVE COLLISIONS IN CARBON NUCLEI. I.Kita.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1099-1106 (June, 1961).

A momentum cloud chamber was operated at Mt. Norikura, 2740 metre above sea level, and about ten thousand pairs of stereoscopic pictures of the events were taken. Selected showers were transformed to the C.M.S. of the collisions to obtain the intrinsic features of the nuclear interactions. In the energy range around 100 GeV of incident nucleons, the successive collision model in carbon nuclei, rather than the complete collision model, seems to be consistent with the experimental evidences.

13540 A CLOUD CHAMBER STUDY OF HIGH ENERGY NUCLEAR INTERACTIONS OF COSMIC RAY PARTICLES. II. RESULTS OF SINGLE NUCLEON—NUCLEON INTERACTIONS. G.Fujioka.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1107-13 (June, 1961).

30 possible nucleon—nucleon interactions of primary energies

around 100 GeV observed in a magnet cloud chamber were analysed in their centre of mass systems. The angular distribution of secondary particles was nearly isotropic. The average values of E^* and p_T were 350 MeV and 220 MeV/c, respectively, the R.M.S. deviations about mean values being 225 MeV and 160 MeV/c. The energy spectrum can be represented as $E^{*-2}dE^*$. The inelasticity of interactions had a tendency to decrease with increasing primary energies. The average inelasticity in the centre of mass system was 0.27 ± 0.05. All interactions had almost equal number of shower particles in the foreward and backward directions in the centre of mass system.

13541 PROPAGATION OF SOLAR COSMIC RAYS THROUGH INTERPLANETARY MAGNETIC FIELD.

T.Obayashi and Y.Hakura.
J. Radio Res. Lab. (Japan), Vol. 7, 379-88 (July, 1960).

In recent years evidence has been accumulating that low-energy solar cosmic ray particles arrive at the earth following intense solar disturbances. The time-delay of polar cap absorptions and of geomagnetic storms, which follow after an intense solar radio outburst of type IV, indicates the fact that solar cosmic ray particles originating to the west of the solar central meridian reach the earth earlier and more easily than those from the east. The model of the interplanetary magnetic field, which may be appropriate for the explanation of this evidence, is as follows; the interplanetary magnetic field is formed by outward-streaming solar winds which carry the imbedded solar magnetic fields, the lines of force being linked with the sun itself. The rotation of the sun produces a curvature of streams and consequently of the lines of force, which are convex towards the west. Since the injected solar particles will tend to travel along the existing magnetic lines of force, this model can give an explanation of the western excess of the arrival of solar cosmic rays as well as the inequality of their travel-time with respect to the heliographic position. It is shown that the estimated intensity of the magnetic field is of the order of 10^{-3} to 10^{-5} gauss near the earth's orbit.

13542 PROPAGATION OF SOLAR COSMIC RAYS THROUGH INTERPLANETARY MAGNETIC FIELD.

T.Obayashi and Y.Hakura.
J. geophys. Res. (USA), Vol. 65, No. 10, 3143-8 (Oct., 1960).

See preceding abstract.

13543 SEARCH FOR HIGH-ENERGY COSMIC GAMMA RAYS.

T.L.Cline.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 109-12 (Aug. 1, 1961).

Results obtained with a directional scintillation—Cherenkov γ-ray detector, flown to 8.5 $g.cm^{-2}$ atmospheric depth at 55°N geomagnetic latitude. The primary flux, extrapolated to 0 $g.cm^{-2}$, is found to be $(1 \pm 3) \times 10^{-3} cm^{-2} sec^{-1} sr^{-1}$, for energies of the order 70 MeV, and corresponds, at the 95% confidence level, to an upper limit of $7 \times 10^{-3} cm^{-2} sec^{-1} sr^{-1}$. The upper limit for γ-rays from Cygnus A, at the same confidence level, is set at $1{\cdot}2 \times 10^{-3} cm^{-2} sec^{-1}$. From the upper limit for the total primary flux, upper limits are also deduced for the frequency of proton—antiproton annihilation in the Galaxy. These are estimated at $6 \times 10^{-23} cm^{-3} sec^{-1}$, for the region in the direction of the North Galactic Pole, and $2.5 \times 10^{-23} cm^{-3} sec^{-1}$, in the direction of the galactic anti-centre. N.A.Porter

SOLAR FLARE TRITIUM IN A RECOVERED SATELLITE.

See Abstr. 12754

13544 PRIMARY COSMIC RAY α-PARTICLES. II.

A.Engler, F.Foster, T.L.Green and J.Mulvey.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1157-81 (June 16, 1961).

For Pt I, see Abstr. 8522 of 1960. Results of investigation of the flux and energy spectrum of cosmic-ray α-particles in August 1958 at a geomagnetic latitude of 61°N are presented. The modulation mechanism proposed by Elliot (Abstr. 17452 of 1960) is shown to provide a good description of the change in the energy spectrum between times of minimum and maximum solar activity.

13545 DETERMINATION OF THE ELECTRIC CHARGE OF A HIGH-CHARGED NUCLEUS OF THE PRIMARY COSMIC RAYS WITH NUCLEAR EMULSIONS.

G.Alvial.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 18-23 (1961).

A new method is described and discussed for the study of the heavy primary component of the cosmic radiation. It permits determination of the charge Z, in nuclear emulsions, with a standard error of less than one unit. One relativistic nucleus with a Z as large as 30 was found.

13546 A NEW EVALUATION OF THE SIMPLE SHADOW

R.Gall and J.Lifshitz.
Rev. Mexicana Fis., Vol. 9, No. 1, 57-72 (1960). In Spanish.

A set of simple shadow cones is calculated for protons of 0.172 GeV (geomagnetic latitude $\lambda = 70°$), 4.49 GeV ($\lambda = 50°$ and 8.61 GeV ($\lambda = 60°$ and 30°), and 14.0 GeV ($\lambda = 50°$, 40° and 30°). assumed that the earth's magnetic field can be represented by eccentric dipole and quadrupole field. The results agree with calculated by Kasper (Abstr. 12416 of 1959) but not with the co found by Schremp (Abstr. 3665-6 of 1938) and it is suggested th latter results are in error. I.C.Demetsop

13547 PRIMARY COSMIC RAYS

J.R.Winckler.
Radiation Research (USA), Vol. 14, No. 5, 521-39 (May, 1961).

Presented at the Symposium on Radiation in Space 1960 Meeting. Surveys information on the primary cosmic rays ava able from sea-level detectors, balloon flights, and from the Pi V space probe. After a brief survey of the known data on the galactic cosmic rays, i.e. their abundance, energy spectrum, isotropy, and modulation, another section deals with the solar mic rays, their generation, energy spectrum, correlation with radio-noise bursts, intensity, and storage. Nonrelativistic cos ray flares are dealt with in greater detail, and their principal perties are summarized. Tables are given of polar cap absorp events, recent solar cosmic-ray events, solar radio emission of continuum radiation (type IV) and solar cosmic rays. A gra given of polar cap bombardment by solar cosmic rays as show by the absorption of galactic radio noise signals in the ionosph D-region. Further graphs deal with the solar cosmic-ray incr observed at Minneapolis on May 12 1959; the series of cosmic- increases observed at Minneapolis and Churchill during July 1 altitude dependence during a period of high intensity; and ion chamber and Geiger counter measurements of solar particles the Pioneer V space probe, 5×10^6 km from the earth. A few of particular interest are discussed in detail and an attempt is to summarize the knowledge pertaining to the rate of occurren intensity. A comparison of events measured with balloons and space probe is given. E.W.Keller

13548 HEAVY PRIMARY COSMIC RADIATIONS. PRINCE ALBERT PROJECT.

H.Aizu, Y.Fujimoto, S.Hasegawa, M.Koshiba, I.Mito, J.Nishimu and K.Yokoi.
Suppl. Progr. theor. Phys. (Japan), No. 16, 54-168 (1960).

A systematic investigation of the heavy primary cosmic radiation is made on the basis of an extensive analysis of the Prince Albert stack. The experimental result described is the first, and to date the only one, to give information on the rigidi spectrum of various components of heavy primaries in the low rigidity region. The general shape of the spectrum, common t components, is found to have a broad maximum which falls aro 2.2 GV with a width of about 0.6 GV. The flux values above the atmosphere of the various components are as follows (in units particles/m^2 sec sterad):

	$1.3 < R < 2.7$ GV	$R > 2.7$ GV
He	40.6 ± 5.2	81.1 ± 7.2
L	1.15 ± 0.13	1.61 ± 0.15
M	3.64 ± 0.32	6.39 ± 0.80
H	1.24 ± 0.16	1.87 ± 0.18.

The effect of solar activity on the heavy primary cosmic radia is discussed. The chemical composition of heavy primaries h following remarkable features: (1) Fe group elements are ove bundant as compared with their abundance in usual stars. (2) overabundant in C, N and O group elements as compared with stars. (3) Ne is underabundant when compared with its abunda in stars and, at the same time, the abundance of Ne is compara to that of Mg. (4) On the whole, it is very similar to that of pl tary nebulae up to elements of $Z \sim 14$. It is tentatively conclu that the main contribution to the cosmic-ray component up to is from late-stage giant stars whereas supernovae account for component of $Z > \sim 20$.

13549 THE INFLUENCE OF ISOTOPIC COMPOSITION O MAXIMUM IN THE COSMIC RAY ENERGY SPECT

M.V.K.Appa Rao and M.F.Kaplon.
Nuovo Cimento (Italy), Vol. 21, No. 2, 369-72 (July 16, 1961).

It is suggested that the observation of a maximum at low energies in the differential spectrum may arise in part from t ce of isotopic heterogeneities in the primary beam. This ent is illustrated by considering the doubly charged component mixture of He^3 and He^4 nuclei: it is shown that the combina- two exponentially declining spectra, with geomagnetic cut-off by the magnetic rigidity, will have a simulated maximum e maximum exists in both the He^3 and He^4 primary spectra, be enhanced if the two are combined without taking into the mixture of masses. Similar effects are shown to occur ingly charged beam which is a mixture of protons, deuterons, tons. N.A.Porter

50 SOME EXAMPLES OF INTERACTIONS OF VERY HIGH ENERGY PROTONS WITH HEAVY NUCLEI OF PHOTO- IC EMULSIONS.

e, Z.Czachowska, R.Holyński and K.Rybicki.
ys. Polon. (Poland), Vol. 20, No. 4, 331-9 (1961).
ree high energy jets ($E_{prim} > 10^{12}$ eV) produced in collisions clei of photographic emulsion are described. In spite of the t they are probably produced in central collisions of s with heavy nuclei they show double maximum angular tions in contradiction to the hydrodynamical model.

i CONTRIBUTION OF ELECTRON TRIDENTS IN CASCADE SHOWERS. S.K.Chakrabarty.

a Mathematical Society Golden Jubilee Commemoration (1958-1959) Part I, p. 217-24 [Calcutta Mathematical , Calcutta-9, India].
study of the generation of high energy soft showers provides ble check on the laws of quantum electrodynamics. Several ational results on the high energy cascades under thin of material have recently been observed particularly in raphic emulsions. In the present paper an estimate has been f the average number of shower particles produced under ayer of material. The contribution of the "trident" process lifferent stages has been estimated, also the ratio of ts" to "pseudotridents". These results when compared e results of observations give some quantitative estimates (i) the relative contributions of the "trident" process and pair creation process, (ii) the validity of the theoretical sections assumed for the different processes particularly energies and, (iii) the nature of the fluctuation in soft s.

2 ON THE DEPENDENCE OF THE PHOTON—ELECTRON RATIO ON THE DISTANCE FROM THE F EXTENSIVE AIR SHOWERS OF COSMIC RADIATION.

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hys. Polon. (Poland), Vol. 19, No. 4, 461-5 (1960).
e transition curves were determined for two distances of uring tray from a detector of extensive air showers. The f the number of photons to the number of electrons was o increase as the mean distance from the axis of the showers ed was augmented (from 20 to 100 m). For the range of es used, a ~ 50% variation of the ratio was found. The sign bserved effect is in agreement with that predicted by the of the electron—photon cascade.

553 ENERGY SPECTRUM OF ELECTRON PAIRS IN A HIGH ENERGY PHOTON-ELECTRON CASCADE.

egr, V.Petržilka, J.Sedlák and J.Vrána.
J. Phys., Vol. 10, No. 5, 342-8 (1960).
e energy spectrum of electron pairs generated in a high photon—electron cascade up to a depth of 1.5 shower unit easured and the possible influence of the medium on the shape spectrum according to Landau—Pomerančuk—Ter Mikaelyan gdal was investigated. Two procedures were used for the is; no significant deviation from the Bethe--Heitler spectrum e observed. Different ways of estimating the primary energy pplied; the resulting value, 2×10^{12} eV, was accepted as the y energy.

554 THE STRUCTURE OF EXTENSIVE AIR SHOWERS NEAR THE AXES. S.Fukui.

s. Soc. Japan, Vol. 16, No. 4, 604-15 (April, 1961).
e lateral distribution of electrons and also of the mean of extensive air showers (EAS) were observed with a r array composed of 14 scintillation detectors, 15 Cherenkov rs, an arrival direction detector and a Ne hodoscope. In lar the precise structure near the axes could be detected by hodoscope. Each EAS was specified by various parameters, , the lateral distributions of electrons and energy flow, ons, and nuclear active component, and it was found that the structure of the EAS thus observed are different from case to case. Near the axis the lateral distributions of electrons were rather flat and varied gradually from $r^{-0.4}$ to $r^{-1.0}$ according to the distance from the axis, up to a few meters. The slope of the distribution between 5 m-50 m distance from the shower axis is well fitted by the predicted one from the Nishimura—Kamata theory (Abstr. 389 of 1960) adjusting the value of the s-parameter. The observed lateral distribution of mean energy of electrons is expressed by $E = 7.5 \times 10^8 \times r^{-0.7 \pm 0.1}$ eV in the region from the axis to 7 m. The probable influences on the structure near the axis are discussed.

13555 LATERAL DENSITY DISTRIBUTION OF CHARGED PARTICLES IN THE CENTRAL REGION OF EXTENSIVE AIR SHOWER.

S.Miyake, K.Hinotani, I.Katsumata, T.Kaneko and N.Ito.
J. Phys. Soc. Japan, Vol. 16, No. 5, 847-54 (May, 1961).

The lateral density distribution of the ionizing particles around the core of the extensive air shower was observed with 10 plastic scintillation counters at mountain altitude (2775 m above sea level). The lateral density distribution, which has so far been expressed by the unique function of the distance from the central axis of the extensive air showers, is made clearer so that it can be expressed by $1/r^n$ approximately in a range of 20 m from the axis, and n varies from 0.8 to 2.0 according to the character of each shower. The result seems to have a relation to the fluctuation which is presented in Abstr. 20252 of 1960, or to the fluctuation of a nuclear cascade in the development of the extensive air showers. The density spectrum was also analysed by a single counter and the result supports the above conclusion.

13556 A STUDY ON HIGH-ENERGY NUCLEAR-ACTIVE PARTICLES IN EXTENSIVE AIR SHOWERS.

Y.Tanaka.
J. Phys. Soc. Japan, Vol. 16, No. 5, 866-80 (May, 1961).

A new type of detector called a transition chamber was used to study high-energy nuclear-active particles (N-particles) above 10^{11} eV in extensive air showers (EAS) of size above 10^3. The differential energy spectrum of N-particles is shown to be represented by $E_N{}^{-2.0 \pm 0.1} dE_N$ up to 3.10^{13} eV irrespective of shower size. The lateral distribution of nuclear-active particles is obtained within 10 m from the axis. This distribution is tentatively explained by a phenomenological model assuming the Maxwell—Boltzmann distribution for the transverse momentum of N-particles. The total number of N-particles of energy $E_N \geq 10^{11}$ eV, N_N, in an extensive air shower is expressed as a function of size N_e by

$$N_N = (50 \pm 5)(N_e/10^5)^{1.1 \pm 0.1},$$

for N_e ranging from 10^3 to $>10^6$. Then the total energy carried by all N-particles of $E_N \geq 10^{11}$ eV is estimated to be as much as that of the electron component in an EAS. On the basis of the observed general relationship between the electron component and N-particles for a wide range of sizes, a model of the development of EAS is suggested. The energy spectrum of N-particles is discussed in relation to that of high-energy γ-rays. In particular the existence of very high-energy N-particles implies that the average inelasticity in high energy interactions $\eta = 0.4 \sim 0.5$, if they are assumed to be survivors of primary particles. Also the possibilities are discussed for the occurrence of N-particles with energies as much as 10% or more of primary particles.

13557 THE SOLAR COSMIC-RAY OUTBURST OF MAY 4, 1960.

J.C.Anderson, R.L.Chasson, M.P.Liwschitz and T.Suda.
J. geophys. Res. (USA), Vol. 65, No. 12, 3889-94 (Dec., 1960).

Low-energy nucleonic cosmic-ray data from stations at Lincoln, Mt. Washington, Sulphur Mountain, and Deep River were studied with regard to onset times, time and magnitude of maximum increase, and decay characteristics. The decay behaviour underwent a definite transition that is clearly related to the termination of the optical flare. The first part of the decay is clearly exponential, with a time constant in the neighbourhood of 17 min, whereas the latter part is not distinctly established either as exponential (with a possible time constant of 78 min) or as following a $t^{-1.5}$ law. Ordinary impact zones do not seem to fit the pattern of increases observed at various stations in the northern hemisphere.

13558 SIDEREAL CORRELATION OF EXTENSIVE AIR SHOWERS. A.N.Suri and B.N.Srivastava.

J. sci. industr. Res. (India), Vol. 20 B, No. 7, 348 (July, 1961).

Extensive air showers of primary energy ~ 10^{15} eV were recorded and data of about 25 000 showers analysed in sidereal time. The amplitude of the diurnal component was found to be (1.32 ± 0.90)% with the time of maximum at 17.1 hr. Although the amplitude is not significant, the time of occurrence of the maximum coincides with the time when the galactic centre crosses the meridian at Naini Tal, where the measurements were made.

13559 FURTHER MEASUREMENTS OF THE SIZE-SPECTRUM OF EXTENSIVE AIR SHOWERS.

J.R.Green and J.R.Barcus.
Nuovo Cimento (Italy), Vol. 21, No. 2, 361-8 (July 16, 1961).

Measurements on the size-spectrum of extensive air showers were made over a period of about one year to include approximately 10^5 events. It is found that errors of about 5% in determining the number of particles traversing the scintillator make it impossible to observe time variations of less than 8%. For showers containing a total number of particles $10^5 < N < 10^7$, the spectrum $K_v(\geq N) = (2.26 \pm 0.14) \times 10^{-7}(N/10^6)^{-(1.540 \pm 0.006)}\,\mathrm{sec}^{-1}\,\mathrm{m}^{-2}\,\mathrm{sr}^{-1}$.

13560 AZIMUTHAL ASYMMETRY IN HIGH ENERGY INTERACTIONS. D.P.Stern.

Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 251-5 (1960).

High-energy meson showers, produced by cosmic-ray particles and detected in nuclear emulsions, may not only possess a definite angular distribution but also be rotationally asymmetric. A method is proposed by which such an asymmetry might be detected, and a way of obtaining its extent — if it exists — is also developed.

13561 CHARACTERISTICS OF HIGH-ENERGY NUCLEAR INTERACTIONS AT AND ABOVE 10^{14} eV.

A.Ueda and C.B.A.McCusker.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 35-51 (July, 1961).

An attempt was made to explain(a) the changes in slope of the γ-ray energy spectrum around γ-energies of 1000 GeV at 220 gm/cm^2 and 740 g/cm^2 from the top of the atmosphere,(b) the change in slope of the extensive air shower density spectrum at sea level at densities of about 1000 particles/m^2,(c) the double change in slope of the energy spectrum of γ-rays from local nuclear interactions at 220 g/cm^2,(d) the absence of such a change at sea level, and (e) the μ-meson spectrum at sea level. The cascade theory developed by Fukuda, Ogita and Ueda (Abstr. 15475 of 1960) was used together with the following basic hypotheses: (i) in a nucleon—nucleon collision the maximum pion energy in the c.m.s. is about 25 GeV, (ii) the fractional energy going into the pion component decreases with increasing primary energy (from 30% at 500 GeV to 5% at 5×10^7 GeV), (iii) at very high energies a large fraction of the energy goes into a few heavier particles and thence some of this, via the Σ^0, into the electromagnetic cascade. Good agreement between theoretical predictions and experimental results has been obtained.

13562 A COMPARISON OF PION AND NUCLEON INTERACTIONS IN NUCLEAR EMULSIONS BETWEEN 10^{11} AND 10^{13} eV.

F.A.Brisbout, C.Gauld, C.B.A.McCusker, J.Malos, K.Nishikawa, L.S.Peak and L.G. van Loon.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 217-21 (Aug., 1961).

Using data obtained from a 10 litre emulsion stack by the Sydney group and a 22 litre stack by the Chicago group, it is shown that at energies around 1000 GeV: (a) the average number of shower particles in secondary jets (mainly produced by pions) is about half that in jets produced by protons, (b) the spread of multiplicities in pion—nucleon encounters at a given energy is small, (c) the spread of multiplicities in proton-produced jets is considerable and in good agreement with the predictions of tunnel theory assuming a geometric interaction cross-section for protons, and (d) the average number of heavy prongs in secondary jets (mostly produced by pions) decreases with increasing energy for about 15 at 6 GeV to about 3 at 5000 GeV.

13563 THE AZIMUTHAL ANGULAR DISTRIBUTION OF SHOWER PARTICLES. V.M.Chudakov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 156-62 (Jan., 1961).
In Russian.

It is shown that the χ^2 criterion can be employed to investigate the azimuthal angular distribution of a small number of shower particles. The azimuthal angular distribution of secondary particles in jets produced in photographic emulsions by cosmic-ray particles is analysed by the proposed method. It is concluded that peripheral collisions of high-energy nucleons play an important role. [English translation in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 107-11 (July, 1961)].

13564 ALTITUDE DEPENDENCE OF EXTENSIVE AIR SHOWERS. É.V.Gedalin.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 178-9 (Jan., 1961)
In Russian.

The altitude dependence of extensive air showers is studie assuming that the absolute amount of energy transferrred to π-mesons in collisions between nucleons with energies $E \geq 10$ and nuclei is constant (in the c.m.s.). As is shown, in order to have the results of the calculation agree with the experimental one must assume that, in secondary interactions of particles (other than π-mesons) which carry away most of the energy in nucleon—nucleus collisions, a constant fraction of the incident-particle energy is imparted to the π-mesons. [English translat in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 123-4 (July,

13565 EXACT SOLUTION OF THE BASIC CASCADE THE EQUATIONS. V.S.Synakh.

Zh. eksper. teor. fiz. (USSR), Vol. 40, No. 1, 194-8 (Jan., 1961
In Russian.

Exact numerical solutions of the basic cascade theory equ obtained by the functional transformation method, are given fo small depths (up to two radiation lengths). [English translatio Soviet Physics - JETP (USA), Vol. 13, No. 1, 134-6 (July, 1961

13566 ON THE BEHAVIOUR OF THE SOFT COMPONEN COSMIC RAYS UNDER THICK LEAD LAYERS.

O.Balea and E.Friedlander.
Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 3, 515-19 (1960)
In Roumanian.

An anomalous increase of the Rossi maximum previously reported by Stoker (Abstr. 4482 of 1956) is shown to be due to variation of the over-all acceptance efficiency of the counter batteries with distance from the lead layer.

13567 DAY TO DAY CHANGES IN THE DAILY MEAN INTENSITY OF COSMIC RAYS.

R.P.Kane, S.R.Kane and B.A.Holla.
Indian J. Phys., Vol. 34, No. 11, 493-505 (Nov., 1960).

Data obtained at Kodaikanal (geomag. lat. 1°N, altitude 23 metres) for cosmic-ray mesons and the nucleonic component analysed for the first 12 months of the IGY (July 1957-June 19 Day-to-day changes of the mean intensity and their relationshi with geomagnetic phenomena are studied. Comparison is mad with neutron monitor data at Huancayo, Ottawa and Resolute. variation spectrum of the type $\delta D(E)/D(E) \propto E^{1}$ is obtained.

13568 THE SOLAR DAILY VARIATION OF THE COSMIC RADIATION: WORLD-WIDE NEUTRON MONITOR OBSERVATIONS DURING THE INTERNATIONAL GEOPHYSIC YEAR. G.Schwachheim.

J. geophys. Res. (USA), Vol. 65, No. 10, 3149-57 (Oct., 1960).

An analysis is given of the quiescent solar daily variation cosmic radiation, as recorded by neutron monitors during the International Geophysical Year. The amplitude of the first harmonic as a function of latitude shows a decrease at polar r but is otherwise constant at 0.3%. The time of maximum incre from 13 to 17 hrs local time from the equator to the pole. The amplitude of the second harmonic is 0.06%, and its time of ma is 1 hr local time. The world-wide correlation of the results also examined.

13569 EFFECTS OF SHORT-TERM WORLD-WIDE MODULATION OF THE PRIMARY COSMIC RADIA ON OBSERVED DAILY INTENSITY VARIATIONS. N.R.Parso

J. geophys. Res. (USA), Vol. 65, No. 10, 3159-61 (Oct., 1960).

The possible magnitude of contributions to the observed s daily variation of cosmic-ray intensity made by irregular sho term fluctuations of the primary intensity is discussed. It is that such fluctuations of an average type and range not inconsi with observed patterns of change in bihourly intensity values c contribute important spurious universal time components to sh period mean daily variations.

13570 EFFECT OF WORLD-WIDE CHANGES OF ISOTRO COSMIC RAY INTENSITY ON THE DAILY VARIAT OF COSMIC RAYS. R.P.Kane.

Indian J. Phys., Vol. 35, No. 5, 213-35 (May, 1961).

Various methods of evaluating the 12 bi-hourly values req for a study of the daily variation of cosmic ray intensity are discussed. Estimates are obtained of the distortions produced genuine daily variation due to slope, curvature and short-term

world-wide fluctuations in isotropic cosmic ray intensity. A
l for correcting for such effects is suggested and examined
lly.

571 TIME VARIATIONS OF DIRECTIONAL COSMIC RAY INTENSITY AT LOW LATITUDES. I. COMPARISON OF
VARIATION OF THE INTENSITY OF COSMIC RAYS INCID-
ROM EAST AND WEST. U.R.Rao and V.Sarabhai.

Roy. Soc. A (GB), Vol. 263, 101-17 (Aug. 22, 1961).
study was conducted at Ahmedabad during 1957 and 1958 of
ne variations of meson intensity incident from east and west at
the vertical. A characteristic difference of about 6 hr in the
l time of maximum for the east and west directions is ob-
l to occur on many days and this is interpreted as signifying
sotropy of primary radiation caused by a source outside the
ce of the geomagnetic field. However, there are many days
ch the daily variation has a maximum near noon for both
ions. On such days the predominant influence is that of a local
situated within the influence of the geomagnetic field. The
ource is associated with geomagnetically disturbed days.
erm changes in the daily variation are found to be similar for
st, vertical and west directions

572 TIME VARIATIONS OF DIRECTIONAL COSMIC RAY INTENSITY AT LOW LATITUDES. II. TIME VARIA-
OF EAST—WEST ASYMMETRY. U.R.Rao and V.Sarabhai.

Roy. Soc. A (GB), Vol. 263, 118-26 (Aug. 22, 1961).
anges of the energy spectrum of primary cosmic radiation
followed through the time variations of east—west asymmetry
μ-meson component at low latitudes. Such a study was con-
for the first time at Ahmedabad during 1957-58. The changes
—west asymmetry are associated with changes of the daily
ion of cosmic-ray intensity, of the daily mean neutron intensity
red at equatorial and middle latitude stations, of the index of
gnetic disturbance and of the horizontal component of the
s magnetic field. The study indicates that days with high
west asymmetry are associated with geomagnetically quiet
nd a cosmic-ray daily variation consistent with its being pro-
by an anisotropy of primary radiation outside the influence of
omagnetic field. On such days, the daily variation produced
anisotropy, as observed at an equatorial station, has a signifi-
iurnal as well as a semi-diurnal component. High east—west
etry and associated anisotropy occur 3 to 5 days before the
l of solar corpuscular beams which envelop the earth. Days
w east—west asymmetry occur about 3 to 4 days after the on-
cosmic-ray storms associated with geomagnetic storms,
y of the SC type.

573 TIME VARIATIONS OF DIRECTIONAL COSMIC RAY INTENSITY AT LOW LATITUDES. III. INTERPRETA-
OF SOLAR DAILY VARIATION AND CHANGES OF EAST—
ASYMMETRY. U.R.Rao and V,Sarabhai.

Roy. Soc. A (GB), Vol. 263, 127-35 (Aug. 22, 1961).
he daily variation of cosmic-ray intensity at low latitudes can
certain conditions be associated with an anisotropy of primary
ion. During 1957-8, this anisotropy had an energy spectrum of
ion of the form $a\epsilon^{-0\cdot8+0\cdot3}$ and corresponded to a source situated
ngle of 112 ± 10° to the left of the earth—sun line. The daily
ion which can be associated with a local source situated along
rth—sun line has an energy spectrum of variation of the form
ncreases in east—west asymmetry and the associated daily
ion for east and west directions can be explained by the
ration of cosmic-ray particles crossing beams of solar plasma
neighbourhood of the earth. For beams of width 5×10^{12} cm
frozen magnetic field of the order of 10^{-4} G, a radial velocity
ut 1.5×10^{8} cm/sec is required. The process is possible only
ejection of beams takes place in rarefied regions of inter-
ary space which extend radially over active solar regions. An
ation of Forbush type decreases observed at great distances
he earth requires similar limitation on the plasma density and
tivity of regions of interplanetary space. The decrease of
west asymmetry associated with world-wide decreases of in-
and with SC magnetic storms is consistent with a screening
low-energy cosmic-ray particles due to magnetic fields in
a clouds.

574 DIURNAL VARIATION OF COSMIC RAY NEUTRON INTENSITY, C.V.Sastry and P.S.Gill.

Nat. Inst. Sci. India A, Vol. 26, No. 1, 41-8 (Jan. 26, 1960).
neutron monitor in operation at Gulmarg Research
vatory since July 1958 is described. The dependence of the
l amplitude of neutron intensity on geomagnetic planetary
Kp was studied. It is shown that there is no apparent relation
between the two. It is also shown that the diurnal amplitude tends to be higher on days of low mean intensity and tends to be lower on days of high mean intensity.

13575 THE SECULAR VARIATION AND THE GEOMAGNETIC THEORY OF COSMIC RADIATION. R.Gall.

J. geophys. Res. (USA), Vol. 65, No. 11, 3545-58 (Nov., 1960).

Discusses the effect of the secular variation of the geomagnetic field on the elements of the eccentric dipole and eccentric dipole—quadripole models. It studies the migration during the period between 1845 and 1955 of geomagnetically equivalent points and examines the conditions for the invariance of the differential equation of motion of charged particles in the geomagnetic field. Formulas and practical rules are given for adapting calculations of cones, cutoff momenta and energies, and directions of incidence, valid for any arbitrary year to any specific year of observation. Time corrections for the curves of cutoff momenta versus geomagnetic latitude were calculated for the period 1845-1955 for points of observation distributed over the southern and northern hemispheres.

13576 CALCULATIONS OF COSMIC-RAY TRAJECTORIES NEAR THE EQUATOR. P.J.Kellogg.

J. geophys. Res. (USA), Vol. 65, No. 9, 2701-3 (Sept., 1960).

New calculations of cutoff rigidities near the equator were carried out on a fast electronic computer, using the 48-parameter expression for the earth's magnetic field. The results are in good accord with observations.

13577 THE COSMIC-RAY EQUATOR AND THE EARTH'S MAGNETIC FIELD.

M.A.Pomerantz, V.R.Potnis and A.E.Sandström.

J. geophys. Res. (USA), Vol. 65, No. 11, 3539-43 (Nov., 1960).

The positions of the cosmic-ray intensity minimum off the west coast of Africa and in the Indian Ocean, respectively were determined from measurements obtained with a shipboard neutron monitor during two voyages between Scandinavia and Australia. The cosmic-ray equator is in accordance with the prediction based upon calculations of modified cutoff rigidities at the first location, but differs by 4° at the second. Contemporary observations of zero magnetic dip indicate that the cosmic-ray intensity minimum coincides with the dip equator at 14°W, but differs in geographic latitude by 2° in the vicinity of 60°E.

13578 VARIATIONS OF INTENSITY AND ANISOTROPY OF COSMIC RAYS MEASURED AT THE GEOMAGNETIC EQUATOR. V.Sarabhai and Satyaprakash.

Proc. Indian Acad. Sci. A, Vol. 51, No. 2, 84-116 (Feb., 1960).

Intensity variations were studied during 1956-57 at the equatorial mountain station of Kodaikanal, using a standard neutron monitor. The data are examined to find the relationship between the day-to-day changes of intensity, the variance of bi-hourly deviations, the occurrence of large bi-hourly deviations at different hours of the day and the associated parameters of the daily variation. The results are related to the electromagnetic state of interplanetary space as determined by streams of solar matter in the neighbourhood of the earth, carrying with them frozen magnetic fields. Comparison is made with the model of Dorman (1953).

13579 LATITUDE-DEPENDENCE OF A FORBUSH TYPE DECREASE. Lekh Vir and P.S.Gill.

Nuovo Cimento (Italy), Vol. 20, No. 3, 498-501 (May 1, 1961).

Latitude-dependence of a cosmic-ray intensity decrease was found. It is shown that the relative amplitude does not flatten beyond the latitude knee. It, rather, goes on increasing even much beyond the knee. It is also seen that the relative amplitude is not symmetrical around the geomagnetic equator.

13580 LATITUDE DEPENDENCE OF NUCLEONIC INTENSITY DURING AUGUST 24-SEPTEMBER 20, 1957.

Lekh Vir and P.S.Gill

Indian J. Phys., Vol. 34, No. 11, 531-2 (Nov., 1960).

During this period a large Forbush type decrease in cosmic radiation intensity occurred. The relative amplitude of the decrease at ten sea-level stations with respect to the decrease at Huancayo shows that the latitude dependence of the decrease extends to at least 82.9°N and is not symmetrical about the magnetic equator.

J.L.Redding

13581 OBSERVATIONS OF SOLAR COSMIC RAYS NEAR THE NORTH MAGNETIC POLE.

K.A.Anderson and D.C.Enemark.

J. geophys. Res. (USA), Vol. 65, No. 9, 2657-71 (Sept., 1960).

Following a large solar flare on July 16, 1959, fluxes of protons in the energy region 85 to 300 MeV in a steep spectral distribution were observed by means of high-altitude balloons over Resolute Bay, Canada. The flare particle intensity decreased rapidly and quite steadily over a period of several days, but on the occasion of the last flight, launched on July 27, a small flux remained above the high-energy cosmic-ray level. At that time the active region in which the flare occurred was nearly opposite central meridian. The time dependence of the particle intensity followed quite well a t^{-3} law for which t equaled zero about 16 hours after the flare. This low-energy cosmic-ray-producing flare was accompanied by large and complex radio noise emission, and the particles produced the usual terrestrial effects of long-enduring polar-cap radio blackout, including large riometer effects. During the magnetic storm, at the time the particles were being admitted at forbidden geomagnetic latitudes to the south, the particle intensity was undisturbed over Resolute Bay.

13582 COMPARISON OF SOLAR COSMIC RAYS INJECTION INCLUDING JULY 17, 1959, AND MAY 4, 1960.

K.G.McCracken and R.A.R. Palmeira.

J. geophys. Res. (USA), Vol. 65, No. 9, 2673-83 (Sept.1960).

Using neutron monitor data obtained at high latitudes, it is shown that cosmic-ray particles of rigidity >1 BW were produced by the solar flare that occurred at 2115 UT on July 16, 1959. The exponent of the integral rigidity spectrum of the radiation was ≤ −8.0. The temporal dependence of the flare radiation was unlike that of earlier flare effects, the intensity requiring ~7 hours to reach its maximum value. No impact zones were observed. Meson data obtained at the time of the flare effect starting at 1031 UT on May 4, 1960, are presented. By considering the above-mentioned flare effects, and those observed previously, it is shown that the time scale of the cosmic-ray flare effect is a highly variable quantity, varying by a factor as great as 36 from event to event. The flares responsible for the four flare effects with the shortest time scales occurred on the western solar limb; those resulting in the flare effects with the longest time scales occurred near the centre of the solar disk. The above facts are shown to support the theoretical model proposed by Piddington (Abstr. 2007 of 1959).

13583 OBSERVATIONS OF SOLAR FLARE RADIATION AND MODULATION EFFECTS AT BALLOON ALTITUDES, JULY 1959.

A.Ehmert, H.Erbe, G.Pfotzer, C.D.Anger and R.R.Brown.

J. geophys. Res. (USA), Vol. 65, No. 9, 2685-94 (Sept., 1960).

Observations of cosmic-ray time variations in the stratosphere were obtained over Berkeley, California (USA), and Lindau, Harz (Germany) during the period of outstanding solar activity in July, 1959. Whereas over Berkeley (geomagnetic latitude 44°N) only modulation of cosmic radiation by solar-controlled processes was observed, additional radiation accelerated in the vicinity of the sun (approximately 46% above normal) was observed over Lindau (geomagnetic latitude 52°N) on July 15. On the assumption that the excess radiation consisted almost entirely of protons, its energy spectrum had the form $N(E)dE \sim E^{-4}\,dE$ and extended up to 400 MeV. According to conventional geomagnetic theory, individual protons of these energies are normally forbidden at geomagnetic latitude 52°N. Their presence over Lindau on July 15 indicates that they were admitted by some mechanism which temporarily lowers the cutoff rigidity at this latitude during a magnetic storm. There is also some indication of further examples of excess radiation over Lindau at atmospheric depths down to 30 mm Hg on July 13, 21, 23 and 31.

13584 AN INVESTIGATION OF THE FORBUSH DECREASES IN THE COSMIC RADIATION. J.A.Lockwood.

J. geophys. Res. (USA), Vol. 65, No. 12, 3859-80 (Dec., 1960).

An analysis was made of the large and rapid Forbush decreases in the cosmic radiation which occurred from 1954 to 1959. Data from the IGY network of cosmic-ray stations were utilized to determine the changes in the primary rigidity spectrum, any significant differences in the onset times, and the existence of anisotropies during the decreases. To evaluate changes in the primary spectrum during a decrease it is necessary to know the spectrum before the event. It was found that this long-term variation is adequately described by a modulation of the primary spectrum given by

$$1 - C(t)\,P^{-1},$$

where $1 \leq C(t) \leq 2.5$ and C (t) is a function of time in the solar activity cycle. For individual decreases the modulation is

$$1 - \{C(t_F)\,P^{-1} + k_F\},$$

where $0 \leq k_F \leq 4\%$ for nucleonic detectors at sea level and mou elevations and $0.6 \leq C(t_F) \leq 2.2$. No systematic variations of t onset times were evident, except for the smaller decreases whe the effect of any superimposed daily variation is important. The primary radiation remained isotropic during the large decrease These events were preceded within 3 hr by a sudden commencen geomagnetic storm. These results are discussed in terms of possible solar-modulating mechanisms.

13585 THE TIME VARIATIONS OF SOLAR COSMIC RAYS DURING JULY 1959 AT MINNEAPOLIS.

J.R.Winckler, P.D.Bhavsar and L.Peterson.

J. geophys. Res. (USA), Vol. 66, No. 4, 995-1022 (April, 1961).

Thirteen high-altitude balloon flights were made at Minneap Minnesota, during the period July 10-18, 1959. This paper summarizes measurements with ion chambers, Geiger counters scintillation counters of the solar cosmic rays accompanying th large flares during that period. Very large fluxes were observe beginning with the main phase of each of the three geomagnetic storms following the flares. During this main phase period, the instrumental results are consistent with protons having a steep energy spectrum and a lower limit at the air cutoff. For examp at 1046 UT on July 15 the integral energy spectrum for protons valid between 88 and 300 MeV was found to be

$$N(>E) = 1.05 \times 10^{8} E^{-2.9}/\mathrm{cm}^2 \text{ sec ster.}$$

The large increase observed in each storm can be interpreted a rapid decrease in the cosmic-ray geomagnetic cutoff coincident the start of the main phase of the storm. The flux returned to normal much sooner than the recovery of the main field of the earth. At the time of the sudden commencement of the geomagn storm, a rapid and appreciable decrease of residual low-intensi solar cosmic rays was observed in two cases. It is suggested t these effects may be produced by ring current systems in the ou field of the earth associated with the geomagnetic storm. Follov the July 15 increase, intensity oscillations in the solar proton st with a period of ½ hr were observed. These oscillations are of unknown origin.

13586 COSMIC RAY EVENTS IN NOVEMBER 1960.

A.M.Conforto and N.Iucci.

Nuovo Cimento (Italy), Vol. 21, No. 2, 294-300 (July 16, 1961).

The principal cosmic-ray events of a remarkable group of solar and geophysical phenomena on November 10 to 15, 1960 a reported. Particular attention is called to the cosmic-ray incre recorded on November 12 at high-latitude stations (≥ 45° geom.) in the nucleonic component only, to its second, distinct peak and to certain peculiarities of the whole phenomenon. In order explain the 5 hours delay in the journey to the earth of the solar cosmic-rays producing this enhancement, it seems necessary t look for some "storage" mechanism and some release process thereafter.

13587 COSMIC RAY PHENOMENA DURING THE NOVEMB 1960 SOLAR DISTURBANCES.

J.G.Roederer, J.R.Manzano, O.R.Santochi, N.Nerurkar, O.Tron R.A.R.Palmeira and G.Schwachheim.

J. geophys. Res. (USA), Vol. 66, No. 6, 1603-10 (June, 1961).

A preliminary analysis of cosmic-ray neutron monitor inte data during the November 1960 solar disturbances is presented. first increase on November 12 is attributed to generation of par icles on the sun, following a class 3^+ flare. A second increase November 12 is interpreted as the arrival at the earth of solar particles trapped in the gas cloud emitted by the sun in connecti with a previous flare. It is shown that the arrival of a further c sweeps away the remaining solar particles. The increase on November 15 is attributed to a new generation of high-energy pa icles by another class 3^+ flare that occurred on the same solar active region. The characteristics of the solar flare increases shown to agree with the conclusions of McCracken and Palmeir regarding the propagation of solar particles in interplanetary sp Data from low latitude stations are used to investigate the Forb decreases and their relation with other solar and terrestrial ev

13588 COSMIC RAY INCREASES DURING THE SUNSPOT MINIMUM OF 1953. J.N.Tandon.

J. atmos. terrest. Phys. (GB), Vol. 21, No. 2-3, 203-4 (June, 19

13589 HIGH NEUTRON AND RADIATION INTENSITIES AT BALLOON ALTITUDES DURING AURORAL DISPLA

S.A.Korff and R.C.Haymes.

J. geophys. Res. (USA), Vol. 65, No. 10, 3163-7 (Oct., 1960).

A balloon flight at 40 km altitude, instrumented with neutro

s, recorded high neutron intensities as well as high
ion levels during an auroral display. The observations are
ent with the possibility that the neutrons were produced by
s of 50 or more MeV in energy at the balloon's altitude.

590 THE COSMIC RAY ALPHA-PARTICLE FLUX DURING SHARP FORBUSH INTENSITY DECREASES. P.Meyer.

hys. Res. (USA), Vol. 65, No. 12, 3881-7 (Dec., 1960).
ring three large Forbush-type intensity decreases which
ed on May 12, July 15, and July 18, 1959 the primary cosmic
particle flux was measured at balloon altitudes. A comparison
e α-particle flux in an undisturbed period on September 28,
nd with the total cosmic-ray intensity as observed by neutron
r stations shows a close correlation between the α-particle
d the total cosmic-ray flux during Forbush decreases. This
e clearly establishes the fact that the proton and α-particle
nents are modulated by a common mechanism during the
ntensity decreases. The measurement of May 16, 1959,
ed an increase in the α-particle flux by 30% within approxi-
9 hr which is not accompanied by a comparable variation in
ton flux. Similar, independent changes in the α-particle
re noted earlier to follow Forbush decreases. During quiet
e primary α-particle flux with energies exceeding 560 MeV
cleon was about 20% higher in 1959 than in 1958. This change
nsity is probably related to the beginning decline in average
ctivity.

91 MU-MESON COMPONENT OF AIR SHOWER BELOW THE GROUND. K.Watanabe.

. Soc. Japan, Vol. 16, No. 5, 855-65 (May, 1961).
e μ-meson component was studied which came from the
cascade of the shower core in the ground and possibly
high concentration of μ-mesons below the ground. The total
can be estimated independently of the energy and multi-
distributions of the secondary particles in the elementary
ns each shower of particles undergoes, and also independently
e fluctuations. This is only because they depend upon the
eature of the nuclear cascade in the shower core. Experi-
data of the multiple penetrating particles (M.P.P.) a feature
h is the high concentration of μ-mesons, could not be inter-
in terms of those of the μ-mesons (i.e., decay products
the nuclear cascades in the ground state initiated by
ng nucleons of high energy in the air shower cores) even
the possible contribution of the K-meson and hyperon
tion in the high energy collisions within nuclear cascades is
nto consideration.

92 HIGH-ENERGY INTERACTIONS OF A HEAVY PRIMARY IN EMULSION.

ó, G.Bozóki, E.Fenyves and E.Gombosi.
Cimento (Italy), Vol. 20, No. 4, 662-6 (May 16, 1961).
o successive high-energy interactions of a heavy primary
-ray particle in emulsion are analysed. The differential
distribution of shower particles generated does not show
nificant deviation from the distribution predicted by the
ynamical theory (Abstr. 2775 of 1959).

93 COSMIC-RAY NEUTRON DEMOGRAPHY. W.N.Hess, E.H.Canfield and R.E.Lingenfelter.

hys. Res. (USA), Vol. 66, No. 3, 665-77 (March, 1961).
e equilibrium spatial and energy distribution is calculated
trons made in the earth's atmosphere by cosmic rays. The
current leaking into space is found, and the density of
decays in the vicinity of the earth is computed for a
determination of importance as a source for the Van Allen
The spectrum and the leakage current below 10 MeV are
ined from multigroup diffusion theory; the leakage above
(<1% of total) is approximated from geometrical arguments.
grated source over each square cm of earth surface (at
netic latitude 44°N) of 6.2 neutrons/sec (1.2 from "knock-on"
ses above 10 MeV and 5.0 from evaporation processes below
) gives an equilibrium spectrum in agreement with the
ccuracy of measured values. This source corresponds to a
average of 4.6 neutrons cm^{-2} sec^{-1}, of which 0.8 leaks into
2.9 form C^{14}, and 0.9 is absorbed in other processes.
tionally trapped neutrons (<0.66 eV) amount to less than 1%
otal leakage, but they contribute substantially to the decay
near the earth (e.g., 40% of total decays at $\frac{1}{2}$ earth radius).

94 MOTION OF LOW-ENERGY SOLAR COSMIC RAY PARTICLES IN THE EARTH'S MAGNETIC FIELD.

rai.
magn. Geoelect. (Japan), Vol. 12, No. 2, 59-69 (1961).
e orbits of the low-energy solar cosmic ray particles in the
earth's dipole magnetic field are calculated and their asymptotic velocity vectors before entering this magnetic field estimated. Although the incident region of these particles is restricted in the area of higher geomagnetic latitudes than 60°, it is clear that there are anisotropic effects, i.e. impact zone effects for the incidence of these particles. Furthermore, the precipitation lines of the incidence are shown to be circular around the geomagnetic north pole. Next, it is shown from the comparison of the calculated results with the observed data that, in the initial stage of the incidence, these low-energy cosmic ray particles tend to impinge upon the earth anisotropically, in accordance with the expectation from the calculated results, and that, slightly before the onset of geomagnetic Sc storms their anisotropic incidence changes into an isotropic one, although there are some exceptional cases. Finally, criticisms and a possible explanation on the features of their incidence after the onset of geomagnetic Sc storms are proposed.

NUCLEUS

13595 SOME PRACTICAL REMARKS CONCERNING THE CALCULATION OF THE PHASE SHIFTS OF THE YUKAWA POTENTIAL. T.Tietz.

Acta phys. Hungar., Vol. 13, No. 1, 57-60 (1961).

The formulae derived depend on whether the radial quantum number l is large or small. Some numerical values illustrate the accuracy of the mentioned phase shifts.

13596 ON THE QUASI-MOLECULAR INTERACTION BETWEEN TWO LIGHT NUCLEI. M.Demeur.

C.R. Acad. Sci. (France), Vol. 252, No. 23, 3544-6 (June 5, 1961).
In French.

Estimates the potential energy of two static rigid nuclei. Concludes that the formation of quasi-molecular states is limited to light nuclei and is favoured by prolate deformation.

R.J.N.Phillips

13597 PAIRING FORCES AND PAIR CORRELATIONS IN THE Pb^{206} NUCLEUS.

V.N.Guman, L.A.Sliv and G.A.Sogomonova.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 341-51 (Jan., 1961).
In Russian.

The residual pairing forces acting between the nucleons in the nucleus are determined. The importance of taking these pairing forces and the pair correlations into account in determining the position and the properties of the levels is demonstrated. The energies, eigenfunctions and transition probabilities of the levels of the Pb^{206} nucleus are derived and compared with experiment. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 232-9 (July, 1961)].

13598 THE EXISTENCE OF A HARD CORE IN THE NUCLEON—NUCLEON INTERACTION USING THE HEITLER—ARNOUS NONLOCAL THEORY. Y.Héno.

C.R. Acad. Sci. (France), Vol. 252, No. 19, 2827-9 (May 8, 1961).
In French.

A second-order calculation leads to the derivation of a hard-core potential whose range is in agreement with experimental results. It is hoped that a fourth-order calculation will show a spin—orbit dependence and also improve the poor value obtained for the magnitude of the potential well.

C.Wilkin

13599 LINEAR POTENTIAL BARRIER MODEL FOR NUCLEAR SURFACE. T.Inoue.

J. Phys. Soc. Japan, Vol. 16, No. 4, 844-5 (April, 1961).

The Sugiyama theory (Abstr. 8873 of 1961), is applied to the calculation of the surface energy of the linear potential barrier for a larger range of K_FX_0. Sugiyama's expressions are reduced to the Thomas—Fermi approximation.

F.Herbut

13600 TABLES OF TRANSFORMATION BRACKETS FOR NUCLEAR SHELL-MODEL CALCULATIONS.

T.A.Brody and M.Moshinsky.
Mexico: Universidad Nacional Autonoma de Mexico (1960) 1xxii + 175 pp.
[Monografias del Instituto de Fisica]. In English and Spanish.

The tables are intended to reduce the labour involved in obtaining numerical results in the evaluation of matrix elements and the calculation of wave functions in the shell model. One basic approximation is made in that the common potential well of the shell model is taken to be that of the harmonic oscillator. It is felt that the relatively slight idealization of the physical situation which this implies as amply compensated for by the possibility of taking into account by means of fairly simple formulae any type of two-particle interaction, without limitation in range.

13601 A SEMI-PHENOMENOLOGICAL MODEL OF THE NUCLEUS BASED ON THE PION—NUCLEON INTERACTION. J.P.Amiet.
Nuovo Cimento Suppl. (Italy), Vol. 18, No. 1, 89-133 (1960).
In French.

Starting from the first non-relativistic approximation to the PS—PV pion—nucleon wave-equation, the author attempts to derive the essential features of the shell model of the nucleus. A term, similar to a spin—orbit coupling term, is quickly derived but to get satisfactory results a scalar potential V must be introduced ad hoc. As an example of the application of this method, the author calculates approximately the energy levels and their splittings for a nucleus with N = 70 and Z = 50 using a harmonic oscillator potential for V. These splittings are of the right order of magnitude and also the parity designations of the levels are in agreement with the original shell model. Magnetic moments calculated on this model fall between the Schmidt lines. C.Wilkin

13602 PAIRINGS IN THE SHELL MODEL. II. M.Umezawa.
Nuclear Phys. (Internat.), Vol. 25, No. 4, 661-73 (June, 1961).

For Pt I see Abstr. 9830 of 1955. Coupling schemes are explained for a system of nucleons interacting with each other through a singlet-paring force in addition to a strong spin—orbit force. Results are applied in particular to ground states of nuclei with $n = 4j_+ + 1$, that is, B^{11} and Al^{27}. Assuming a strong spin-orbit force, it is found that the effect of the pairing force in mixing the spin—orbit partners in a j—j coupling scheme is comparatively large near closure of the j—j subshells. The ratio $V_{\sigma l}/V^0$ of the depths of the pairing force and spin—orbit force is chosen for each nucleus so that the deviation of the nuclear magnetic moment from the j—j limit would be explained by the competition of the two forces. It is found that such a ratio becomes relatively larger as the nucleus becomes heavier irrespective of the parity of the orbital state of the individual nucleon.

13603 PAIRING PLUS QUADRUPOLE FORCE MODEL FOR ODD-MASS SINGLE CLOSED-SHELL NUCLEI. R.A.Sorensen.
Nuclear Phys. (Internat.), Vol. 25, No. 4, 674-86 (June, 1961).

An intermediate-coupling calculation is performed for odd-mass nuclei with the neutrons or protons at a closed shell. The Hamiltonian, an adiabatic approximation to the pairing force plus quadrupole Hamiltonian, is diagonalized to include all states containing up to two-phonons of quadrupole vibration. The validity of the approximations is discussed. The level energies and wave-functions resulting from the calculation are compared with experimental results and with the results of Kisslinger and Sorensen (Abstr. 17458 of 1960).

13604 A CLUSTER MODEL REPRESENTATION FOR THE 3-BODY GROUND STATE. J.E.Young and P.R.Stein.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 97-107 (July, 1961).

Considers the representation of the three-body ground state as a deuteron plus extra particle. Calculations in this model are done in a very approximate way. In particular, the actual Hamiltonian of the system is not diagonalized in any order. The "model" Hamiltonian containing the chosen nuclear correlations is, of course, utilized properly. Calculations are presented of the magnetic moment and Coulomb radius for the specific model. The latter result, plus that arising from diagonalization of the "model" Hamiltonian and wave-function normalization, furnishes a set of three equations. In the analogous intermediate coupling expansion of the ground state, there are an equal number of admixture coefficients to be determined. Basis wave-functions in the deuteron and extra particle are given. These are generated by a separable, non-local potential and are particularly well-suited for eventual diagonalization of the actual Hamiltonian through a variational principle.

13605 PAIRING AND QUADRUPOLE FORCES IN A TWO-DIMENSIONAL SOLUBLE MODEL. H.J.Lipkin.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 147-60 (July, 1961).

The model treated is a system of particles moving in a two-dimensional harmonic oscillator potential with two-body pairing and quadrupole forces mixing states within a single major shell (the j—j coupling shell model). A simple representation is found in which the Hamiltonian is exactly diagonal. An "energy gap" is obtained in the limit of pure pairing forces and rotational spectra in the limit of pure quadrupole forces. In the intermediate reg the spectrum varies from energy gap to rotational as the numb of particles is increased. The effective moment of inertia of t rotational band is unaffected by the pairing force, remaining constant at the value for a pure quadrupole force. The model i also treated by replacing the quadrupole force by a self-consis deformed field and the moment of inertia is calculated using th cranking model. The results agree with the exact solution. Implications of the model for more realistic cases are discuss

13606 EQUILIBRIUM FAMILIES IN THE LIQUID DROP MODEL. S.Gallone.
Nuovo Cimento (Italy), Vol. 21, No. 1, 194-6 (July 1, 1961).

Investigates quantitatively the interrelation betwee different series of equilibrium shapes. E.A.Sand

13607 REDUCED WIDTHS FOR NUCLEON CLUSTERS IN SHELL MODEL. Yu.F.Smirnov and D.Chlebowska
Nuclear Phys. (Internat.), Vol. 26, No. 2, 306-20 (Aug., 1961).

The reduced widths of nucleon clusters for certain low lev of p-shell nuclei are calculated on the basis of the shell model. results of the calculation are in good agreement with experime. In certain cases, when the nature of the excited state is not uni determined, the comparison with experiment of the reduced wi of nucleon clusters for different variants of the structure of the wave-functions makes it possible to eliminate non-uniqueness. formal problems involved in calculation techniques are treated detail. Simple expressions for the fractional parentage coeffic are given for the separation of several nucleons.

13608 PAIR CORRELATION EFFECTS NEAR CLOSED SH S.I.Drozdov and D.F.Zaretskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 286-95 (Jan., 196
In Russian.

Pair-correlation effects are studied for nuclei that are clo to shell. Equations for the Green's functions are obtained. It i shown that these equations are valid to within corrections of the order $A^{-1/3}$. A possibility is indicated for testing the results by means of stripping or pick-up reactions. [English translation i Soviet Physics - JETP (USA), Vol. 13, No. 1, 194-9 (July, 1961)

13609 NOTE ON THE PAIRING CORRELATION IN NUCLE MATTER. T.Marumori, T.Murota, S.Takagi, H.Tanaka and M.Yasuno.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1035-42 (June, 1961

A difficulty in applying the Bardeen—Cooper—Schrieffer—Bogolyubov formalism literally to the nuclear system with singu interaction is pointed out (Abstr. 1708, 7034, 7036 of 1958). A prescription to overcome this difficulty is proposed. According to this method, it is possible to join the BCSB formalism consis ly with the "reaction matrix" formalism. The results obtained verify the validity of the basic conjecture underlying Cooper—M Sessler's procedure (Abstr. 12187 of 1959).

13610 SUPERFLUIDITY OF NUCLEAR MATTER. L.P.Rapoport and S.G.Kadmenskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 183-93 (Jan., 1961
In Russian.

Using Bogolyubov's method, the author treats the possibilit superfluidity of nuclear matter and of He^3 for the case of realis interactions between fermions in S-states. It is shown that in th normal state, near the Fermi surface, repulsion rather than attraction predominates for a pair of nucleons with opposite mo and spins. However, because of renormalization of the repulsiv term in the compensation equation, nuclear matter may become superfluid. The reason for the absence of superfluidity for He^3 is given. [English translation in: Soviet Physics - JETP (USA), Vol. 13, No. 1, 127-33 (July, 1961)].

13611 THE THEORY OF THE SUPERFLUID STATE OF A SYSTEM OF FERMI-PARTICLES WITH ISOTOPIC SPIN. I. B.B.Dotsenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 300-12 (1959). In Ukrai

The energetic states of a system of Fermi particles having both spin and isotopic spin — i.e. nuclear matter — are conside employing the methods of Bogolyubov. The lowest energetic sta is found to be a superfluid state. There is an energy gap betwee this state and the normal state. The energy of one-fermion exci tion is also found; it is separated from the ground superfluid st by the energy gap. The case, when the Fermi energy of proto differs from that of neutrons is discussed.

12 **THE TENSOR INTERACTION AND NUCLEAR MATTER.** B.L.Scott and S.A.Moszkowski.
Phys. (USA), Vol. 14, No. 1, 107-19 (July, 1961).

'he separation method of Moszkowski—Scott was applied to lculation of the properties of nuclear matter using two ent nucleon—nucleon potentials, both in reasonable agreement wo-body data. Calculations with the potential of Brueckner—nel gave $E/A = -14.2$ MeV at an equilibrium density corres-ng to $k_f = 1.5\ f^{-1}$. The difference from the results of B and G e caused by slow convergence of the series (especially in the t-even state where the tensor interaction has a large second contribution). An important factor in obtaining nuclear satur-is shown to be the weakening of tensor interaction effects by ermi sea. Evidence for this may also be seen from the results ned using a different two nucleon potential which, however, still good fits to two body data. The potential chosen has a much er tensor component and shows no sign of saturation at al densities (at $k_f = 1.5\ f^{-1}$, $E/A = -23.4$ MeV). The difference two results appears to be much larger than can be accounted ither by higher order terms or by differences in the phase approximation to the reaction matrix.

613 **GROUND-STATE PROPERTIES OF NUCLEAR MATTER.** R.D.Puff.
Phys. (USA), Vol. 13, No. 3, 317-58 (June, 1961).

Develops an approximate method for treating large bound ms in their ground states, based on the Green's function alism of Martin and Schwinger (Abstr. 896 of 1960). In particu-he effective interaction is a free-space reaction matrix.
R.J.N.Phillips

3614 **BASIC PROPERTIES OF THE SUPERFLUID MODEL OF THE NUCLEUS.** V.G.Solov'ev.
. Akad. Nauk SSSR, Vol. 139, No. 4, 847-50 (Aug. 1, 1961).
ıssian.

The dependence of the energies and correlation functions of the nd and two-quasiparticle excited states on the pairing interaction tant G, is calculated for the superfluid model of the nucleus. results are compared with those obtained using the original ıulation of pairing correlations and it is shown that the super-model predicts much more accurately the properties of strongly-rmed even nuclei. The dependence on G of the non-orthogonality e 0- states to each other and to the ground state is analysed. It stimated that errors in the calculations due to conservation of ıumber of particles are of the order of 5%. [English translation Soviet Physics—Doklady (USA)]. T.Burke

3615 **A SIMPLE STUDY OF THE NUCLEAR SELF-CONSISTENT FIELD PROBLEM.** N.V.V.J.Swamy.
an J. Phys., Vol. 35, No. 4, 170-6 (April, 1961).

Assuming a nucleon—nucleus potential and a phenomenological eon density distribution, a Hartree-type self-consistent field ulation is carried out for O^{16}. Three cycles indicate that the eus collapses in each cycle if only a pure central attraction he Yukawa type is assumed to exist between the nucleons. oduction of a repulsive core, other than the usual hard-sphere , leads to the conclusion that angular-momentum dependent entials have to be used in order to obtain convergence in cessive cycles and adequate binding energy of the nucleus. An mate is made of the correlation length of the resulting nonlocal ential, also of the effective mass as a function of position.

13616 **COLLECTIVE MODEL DESCRIPTION OF GROUND STATES OF MEDIUM NUCLEI.**
'al'ter, I.I.Zalyubovs'kȳi and V.P.Lutzȳk.
ayin.fiz. Zh. (USSR), Vol. 4, No. 6, 698-707 (1959). In Ukrainian.

The experimental data concerning these nuclei are analysed on basis of a collective model. Equilibrium deformations are culated. Theoretical predictions for spin, parity magnetic dipole l electric quadrupole moments are compared with the experi-ntal data and with the theoretical values given by the shell del. The conclusion is that the collective model may be used for description of ground states of medium nuclei.

THE NUCLEAR BINDING ENERGY OF THE LIGHT ELEMENTS D THE SATURATION OF NUCLEAR FORCES. See Abstr. 13361

13617 **A METHOD FOR DETERMINING THE SPIN OF A COMPOUND NUCLEUS IN THE SCATTERING OF UTRONS BY POLARIZED NUCLEI.** P.G.De Gennes.
R. Acad. Sci. (France), Vol. 252, No. 23, 3571-3 (June 5, 1961).
French.

In a target formed by a magnetic material, there exists at low temperatures, a cross term between the resonant nuclear scattering and the magnetic scattering of the neutrons. This term enables, in favourable cases, the determination of the spin of the compound nucleus without the use of polarized neutrons. E.A.Sanderson

13618 **ISOBARIC-SPIN RELATIONSHIPS BETWEEN NUCLEAR SPECTRA.** J.B.French.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 161-7 (July, 1961).

The simple fact that a one-body energy describes the interaction of a nucleon with a closed neutron subshell is used to establish sets of equations connecting the spectra of nuclei which are related by isobaric-spin when described by means of the nuclear shell model. Certain formal questions about isobaric spin are incidentally considered.

13619 **ISOBARIC-SPIN SPLITTING OF SINGLE-PARTICLE RESONANCES.** J.B.French and M.H.Macfarlane.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 168-76 (July, 1961).

When a single proton is added to, or a single neutron removed from, a definite shell-model orbit in a target nucleus, the total strength can in general be divided into two parts, each part being characterized by a definite value of the isobaric spin T. This separation is pertinent even when the target isobaric spin is a redundant quantum number determined simply by the neutron excess, and probably in many cases when the isobaric spin is not conserved in the individual states which contribute to the strength. General expressions are given for the total strengths and for the strengths of the T-components. The practical problem of observing this effect as a T-splitting of giant resonances is discussed briefly.

13620 **MAGNETIC DIPOLE MOMENTS OF ODD-MASS NUCLEI IN THE SPHERICAL REGION.**
N.Freed and L.S.Kisslinger.
Nuclear Phys. (Internat.), Vol. 25, No. 4, 611-23 (June, 1961).

The magnetic dipole moments of odd-mass nuclei are calculated and compared to the experimental data for nuclei with particles in the 28-126 shells, except for the deformed region of $150 \leq A \leq 190$. The wave-functions upon which the calculation is based are admixtures of seniority-one wave-functions produced by a pairing interaction and obtained by projecting eigenfunctions of the number operator out of Bardeen-type wave-functions. Perturbation theory is used to compute the seniority-three admixtures produced by a delta-function residual interaction.

13621 **THE MAGNETIC MOMENT OF THE SECOND EXCITED STATE OF F^{19}.** R.M.Freeman.
Nuclear Phys. (Internat.), Vol. 26, No. 3, 446-51 (Aug., 1961).

The moment was determined by a direct measurement of the Larmor precession frequency after the state had been excited in the reaction $F^{19}(p, p')F^{19*}$. A value of $+3.69 \pm 0.04$ n.m. was obtained where the error mainly arose from statistics. Systematic errors were believed to be small by comparison.

13622 **NUCLEAR MAGNETIC MOMENT RATIO AND LINE-WIDTHS OF N^{14} AND N^{15}.**
H.R.Brooker, P.J.Haigh and T.A.Scott.
Phys. Rev. (USA), Vol. 123, No. 6, 2143-5 (Sept. 15, 1961).

The ratio of the nuclear magnetic moment of N^{14} to that of N^{15} in liquid nitrogen was measured using the technique of nuclear magnetic resonance. The value obtained is $\mu(14)/\mu(15) = 1.4257641 \pm 0.0000010$. The true linewidths (between points of maximum slope) were determined to be 24±4c/s for N^{14} and <4 c/s for N^{15}.

13623 **QUADRUPOLE MOMENT OF THE FIRST EXCITED NUCLEAR STATE OF Fe^{57}.**
A.Abragam and F.Boutron.
C. R. Acad. Sci. (France), Vol. 252, No. 16, 2404-6 (April 17, 1961).
In French.

From recent experimental results on the Mössbauer effect, the quadrupole moment of the first excited state of Fe^{57} is found to have positive sign and to be of the order of magnitude 0.1 ± 0.025 barn.
E.A.Sanderson

13624 **QUADRUPOLE MOMENTS OF SOME HEAVY NUCLEI AND COLLECTIVE MODELS.** R.Foucher.
J. Phys. Radium (France), Vol. 21, No. 5, 445-6 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Values of the quadrupole moments of Rn^{220}, Rn^{222}, Ra^{224}, Ra^{226} and U^{234} obtained from the half-lives of the 2+ excited states and the α-γ and γ-γ perturbed angular correlations are compared. The values of the gradients are deduced of the crystalline electric fields applied to these nuclei.

13625 TABLES OF VALUES OF ANGULAR MOMENTA AND ELECTRIC QUADRUPOLE MOMENTS OF STATES ASSOCIATED WITH THE QUADRUPOLE—QUADRUPOLE INTERACTION IN A HARMONIC OSCILLATOR. A.Barragán.
Rev. Mexicana Fis., Vol. 9, No. 3, 129-47 (1960). In Spanish.

The energy levels for a system of N particles in a common harmonic oscillator potential with mutual quadrupole—quadrupole interactions are calculated, using the theory developed by Bargmann and Moshinsky (Abstr. 20082 of 1960). Each level is labelled by the value of the energy of the reduced two-particle state ρ, its pseudo-spin f, its total angular momentum λ and its quadrupole moment ω'. The levels associated with the harmonic oscillator energies $E = 0, 1, \ldots, 12$ are displayed graphically. I.J.R.Aitchison

13626 CHARGE DISTRIBUTION IN Be^9. Y.R.Waghmare.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 681-3 (Sept., 1960).

The elastic scattering of 300 MeV electrons by Be^9 is calculated in Born approximation using a Fermi distribution, and the results are compared with experiment. It is reported that the experimental results cannot be fitted with a monopole charge distribution but require a sizable quadrupole term. The results for 420 MeV electron scattering are also calculated with this charge distribution. L.L.Green

13627 COULOMB ENERGIES AND NUCLEAR RADII. N.V.V.J.Swamy.
J. sci. industr. Res. (India), Vol. 20A, No. 6, 303-7 (June, 1961).

Gives a short review of recent theoretical estimates of Coulomb energy differences of mirror nuclei and of attempts to reconcile such estimates with experimental values. L.L.Green

13628 NUCLEAR POLARIZATION IN A MESIC DEUTERIUM ATOM. M.Demeur and C.Joachain.
J. Phys. Radium (France), Vol. 21, No. 5, 451 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). See Abstr. 17485 of 1960.

13629 ON THE PREPONDERANCE OF PROLATE DEFORMATIONS IN NUCLEI. R.H.Lemmer and V.F.Weisskopf.
Nuclear Phys. (Internat.), Vol. 25, No. 4, 624-33 (June, 1961).

An attempt is made to understand the preponderance of prolate nuclear deformations in terms of a simple Nilsson-type model for the deformed nucleus.

13630 THE MÖSSBAUER EFFECT: A TOOL FOR SCIENCE. G.K.Wertheim.
Nucleonics (USA), Vol. 19, No. 1, 52-7 (Jan., 1961).

A review of the effect in which gamma emission and absorption takes place in a solid with the whole crystal, rather than the individual atom, absorbing the recoil energy. The photons then have an energy almost equal to the nuclear transition energy. The fractional uncertainty in energy depends only on the lifetime of the excited nuclear state and may be as low as one part in 10^{13}. The experimental observation of the effect, its use in nuclear spectroscopy (including measurement of hyperfine structure), measurement of gravitational shift and possible future measurements in solid-state physics are discussed. R.D.Smith

13631 THE THEORY OF THE MÖSSBAUER EFFECT. J.Petzold.
SB Heidelberg. Akad. Wiss. (math. nat. Kl.) (Germany), 1961, No. 5, 45 pp. In German.

A review article concerned with the systematic presentation of the theory underlying the Mössbauer effect. S.J.St-Lorant

13632 RESONANT GAMMA-RAY ABSORPTION,WITHOUT NUCLEUS RECOIL,BY Ho^{166} AND Os^{193}.
A.Bussière de Nercy, M.Langevin and M.Spighel.
J. Phys. Radium (France), Vol. 21, No. 5, 288-90 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Recoilless resonant absorption has been observed for the 129 keV γ-rays of Os^{191} and the 100 keV of Ta^{182}. The same experimental method shows this effect for the 80 keV γ-rays of Ho^{166} and the 73 keV of Os^{193}. A search for a nuclear Zeeman effect supplies a maximum value of two for the magnetic moment of the 73 keV excited state of Ir^{193}.

13633 OBSERVATION OF RESONANCE ABSORPTION OF GAMMA RAYS IN Zn^{67}.
S.I.Aksenov, V.P.Alfimenkov, V.I.Lushchikov, Yu.M.Ostanevich
F.L.Shapiro and Yen Wu-Kuang.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 88-90 (Jan., 1961
In Russian.

Experiments on the observation of recoilless resonance ab tion of the 92 keV γ-rays of Zn^{67} are described. A positive resu was obtained for metallic zinc at liquid-helium temperature. T effect is very small. [English translation in: Soviet Physics— JETP (USA) Vol. 13, No. 1, 62-4 (July, 1961)].

13634 ON THE EFFECT OF n—p TENSOR FORCES IN ^{3}H B.Barsella and S.Rosati.
Nuovo Cimento (Italy), Vol. 20, No. 5, 914-27 (June 1, 1961).

Calculations are made on the hypertriton with a Hamiltonia containing a neutron—proton potential with a tensor part. The integral volume of Λ—N interaction and the wave-function para meters are modified to a certain extent with respect to the resu of preceding calculations, performed with a purely central pote It is concluded that a more refined calculation will be necessar get a definite answer to the question of the importance of n—p corrections in ${}_\Lambda H^3$.

13635 THE Λ^0—NUCLEON INTERACTION IN LIGHT HYPERNUCLEI. P.B.Jones.
Proc. Roy. Soc. A (GB), Vol. 261, 443-56 (May 23, 1961).

The binding energies of the hypernuclei ${}_\Lambda H^3$, ${}_\Lambda H^4$, and ${}_\Lambda He^5$ investigated by a method which includes the effect of a possible hard core in the Λ^0—nucleon potential. It is found that a centra (non-exchange) spin-dependent potential with a hard core of var radius leads to the observed Λ^0 binding energies. It is shown t the existence of the hyperdeuteron (${}_\Lambda H^2$) is most unlikely.

13636 ON THE BINDING ENERGIES OF MESIC HYPERNUCLEI.
Y.Prakash, P.H.Steinberg, D.A.Chandler and R.J.Prem.
Nuovo Cimento (Italy), Vol. 21, No. 2, 235-48 (July 16, 1961).

A detailed analysis of 76 mesic decays of hypernuclei, foun a G-5 emulsion stack exposed to stopping K$^-$-meson beam at Berkeley is reported. The binding energies of the known decay modes are in good agreement with the previously reported valu A value for the binding energy of ${}_\Lambda H^3$ is given based on data reported here and in the literature. Some new and rare decay modes were observed and are discussed.

DOUBLE HYPERFRAGMENTS. See Abstr. 13515

Energy Levels

13637 TWO-BODY POTENTIALS AND EXCITED STATES NUCLEI. I. J = 0—2 ENERGY LEVEL SPLITTINGS
P.Tarjanne.
Ann. Acad. Sci. Fennicae A VI (Finland), No. 64, 10 pp. (1960).

The J = 0—2 energy level splittings in even—even nuclei ar predicted by using a Signell—Marshak-like potential (Abstr. 24 of 1958) and calculating the interaction matrix elements by an approximation method due to Moshinsky (Abstr. 5542 of 1957; 1892 of 1958). The absolute values found are of the correct ord of magnitude; the relative values are correct to within an error 10% for the 22 nuclides investigated.

13638 TWO-BODY POTENTIALS AND EXCITED STATES NUCLEI. II. P.Tarjanne.
Ann. Acad. Sci. Fennicae A VI (Finland), No. 74, 12 pp. (1961).

The $J = 0^+—2^+—4^+$ and $J = 0^+—2^+—2^+$ spin parity scheme nuclei in the intermediate mass region $40 < A < 140$ are investi gated, a modified Signell—Marshak potential and Moshinsky's momentum series method being used in the calculation of the m elements. The classification of about 60 excited states of more 30 nuclides are thus quantitatively verified. The j-doublet split of odd nuclei are calculated from the same potentials. Two diff methods give fair absolute agreement and good relative agreem with the experimental data available. Some integrals useful in explicit calculations of nuclear spectra are tabulated.

639 INELASTIC SCATTERING OF HIGH-ENERGY PROTONS AND LEVELS OF NUCLEI. Y.Sakamoto.

:ar Phys. (Internat.), Vol. 25, No. 4, 687-97 (June, 1961).
:he high-energy protons scattered from some levels of nuclei
ccounted for by means of the radiative widths or lifetimes of
evels without using the wave-functions of the ground and
ed states of nuclei. The inelastically scattered protons at high
ies give information on the spin, parity and isobaric spin
s for the levels. Some levels of C^{12} are considered as
ples.

640 THE VIBRATIONAL EXCITATION OF EVEN—EVEN NUCLEI. M.Jean.

ys. Radium (France), Vol. 21, No. 5, 416-23 (May, 1960).
ench.
ow and Mean Energy Nuclear Physics Colloquium, Grenoble,
(see Abstr. 12029 of 1961). A short survey is given of the
ent state of the systematics and interpretation of the first
ed levels of even-even nuclei in the region between the magic
i and the strongly-deformed ones.

641 REGULARITIES IN THE BRANCHING RATIOS FROM THE HIGHER EXCITED STATES OF THE EVEN-EVEN LEI. R.van Lieshout, R.A.Ricci and R.K.Girgis.

o Cimento (Italy), Vol. 21, No. 2, 379-82 (July 16, 1961).
It is pointed out that states above the first and second 2^+ excited
s in vibrational nuclei tend to decay preferentially to the higher
ose states. The result is most noticeable for 4^+ states decaying
re quadrupole emission but persists where the multipolarities
γ transitions are not known with certainty. Possible inter-
tions of this result are discussed. L.L.Green

642 EXCITATION ENERGY OF THE FIRST 2^+ LEVEL OF EVEN—EVEN NUCLEI. C.Ythier and R.Van Lieshout.

ys. Radium (France), Vol. 22, No. 1, 23-6 (Jan., 1961).
ench.
The energy variation of the first excited state in even—even
i, as a function of the neutron number, shows a fine structure.
existence of this effect has already been reported by Chupp et al.
tr. 2706 of 1961) for the region $96 < N < 126$ and is confirmed by
recent data. An analogous effect seems to be present in the
on $30 < N < 46$.

643 OCTUPOLE VIBRATIONS OF DEFORMED EVEN NUCLEI. P.O.Lipas and J.P.Davidson.

ear Phys. (Internat.), Vol. 26, No. 1, 80-90 (July, 1961).
To explain the systematic occurrence of K = 0− and K = 2−
s in deformed even nuclei, the nuclear surface is assumed to
two octupole degrees of freedom, corresponding to the spheric-
rmonics Y_{30} and $Y_{3\pm2}$, in addition to the β and γ quadrupole
ees of freedom. An approximate Hamiltonian, valid for small
lations about a spheroidal equilibrium shape, is constructed
the hydrodynamic moments of inertia. Separation of the
ödinger equation immediately gives β vibrations (K = 0+, I = 0,
...) and "b vibrations" (K = 0−, I = 1, 3, 5, ...). The remaining
tion is solved formally as a degenerate perturbation problem.
result gives rise to two bands with K = 2, which are interpreted
e γ vibrational band (K = 2+) and a "g vibrational band"
2−), both with spin sequence I = 2, 3, 4, ... The theory is
istent with experiment in the strongly deformed regions.

644 ENERGY LEVELS OF EVEN NUCLEI ON THE HYDRODYNAMICAL MODEL WITH VIBRATION— ATION INTERACTION. E.D.Klema, C.A.Mallmann and P.Day.

ear Phys. (Internat.), Vol. 25, No. 2, 266-77 (May, 1961).
The Davydov and Chaban (Abstr. 2169 of 1961) model for even
ei, in which the beta-vibration-rotation interaction is taken
account exactly, was used to calculate the excited states of
e nuclei. The calculated energies were compared with experi-
al data, special attention being paid to nuclei with known 0+
ted levels. Where possible, comparison was made also with the
elation of experimental data by means of the perturbation
oach of Mallmann and Kerman (Abstr. 11320 of 1960) and of the
-Mottelson model.

3645 MULTIPLE COULOMB EXCITATIONS OF VIBRATIONAL NUCLEI. D.W.Robinson.

ear Phys. (Internat.), Vol. 25, No. 3, 459-71 (June, 1961).
An analysis is made of the multiple Coulomb excitation of
ational nuclei taking into account both one-phonon and two-
on processes. Some of the results of Alder and Winther (Abstr. 17487 of 1960) concerning the one-phonon transitions are re-derived together with some new results concerning the excitation of the triplet of substates forming the second excited state. It is shown that the weak two-phonon processes can affect the excitation probabilities through interference with the strong one-phonon processes. The interference is destructive at energies for which a particular state is being primarily excited and constructive at higher energies for which the state is being de-excited in favour of higher states.

13646 ANALYSIS OF RECENT MEASUREMENT OF NUCLEAR LEVEL DENSITY PARAMETERS. D.W.Lang.

Nuclear Phys. (Internat.), Vol. 26, No. 3, 434-45 (Aug., 1961).

Data from experiments leading to values of the nuclear logarithmic level density derivatives are analysed and shown to be reasonably self consistent. A modified form of the curve drawn by Newton (Abstr. 7613 of 1956) for the value of the single particle level density parameter a is found to be in accord with the data. Attention is drawn to the effect of restriction of the allowed angular momentum of the emitted particles on the value found for the temperature in an evaporative process.

13647 THE COLLECTIVE MODEL OF DEFORMED NUCLEI WITHOUT AXIAL SYMMETRY. P.Boskma.

Ned. Tijdschr. Natuurkde (Netherlands), Vol. 26, No. 6, 175-87 (June, 1960). In Dutch.

Text of a lecture at a symposium on nuclear spectroscopy. A survey is given of various theories of the spectra of nuclei far from magic number nuclei; special attention is paid to the Bohr—Mottelson and Davydov—Filippov theories. D.ter Haar

13648 ISOTOPE SHIFT IN AXIALLY ASYMMETRIC NUCLEI. M.L.Rustgi.

Phys. Rev. (USA), Vol. 123, No. 6, 2110-11 (Sept. 15, 1961).

The effect of axial asymmetry on energy-level isotope shift, as introduced in the theory of Davydov and Filippov (Abstr. 1722 of 1959), is investigated and is found to be non-negligible. An accurate experimental study of the isotope shift may therefore provide evidence in favour of or against Davydov—Filippov's theory for deformed nuclei.

13649 ISOMERIC STATES OF ODD—ODD NUCLEI FROM THE POINT OF VIEW OF A COLLECTIVE MODEL.

A.K.Val'ter, I.I.Zalyubovs'kȳi, G.E.Krȳvets' and V.P.Lutzȳk.
Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 689-96 (1959). In Ukrainian.

It is shown that the difficulties encountered in the explanation of nuclear isomerism on the basis of a shell model may be removed if the conception of a collective model is accepted.

13650 SPLITTING OF NEUTRON ENERGY LEVELS DUE TO SPIN—ORBIT COUPLING. A.Ghosh.

Indian J. Phys., Vol. 34, No. 6, 260-2 (June, 1960).

The splitting due to spin—orbit interaction of the energy levels of neutrons moving in the potential

$$V = V(r) + \alpha \frac{h^2}{M^2C^2} \frac{1}{r} \frac{dV}{dr} \vec{\sigma}.\vec{l}$$

is calculated for p-states for atomic mass 200. The effect of the spin—orbit coupling is calculated by the perturbation method with the unperturbed wave-functions as obtained by Ghosh and Sil by the technique of Lanczos (1938).

13651 EXCITATION OF LEVELS BY INELASTIC NEUTRON SCATTERING.

F.Lehar, J.Palečková, J.Skřivánek and M.Veselá.
Czech. J. Phys., Vol. 11, No. 4, 229-43 (1961).

A scintillation spectrometer in ring geometry was used to study the gamma-rays accompanying the inelastic scattering of fast neutrons on Na, Mg, Mn, Fe and I. The energies of the gamma-rays were in most cases arranged into the cascade decay schemes of excited nuclei. Some of the transitions, which had not yet been described, were also found. These are the lines (2147 ± 21) keV for Mg^{25}, (2135 ± 22) keV, (2750 ± 40) keV, (3040 ± 50) keV and (3200 ± 50) keV for Mn^{55} and a series of other gamma-rays emitted during the interaction of fast neutrons with I^{127}, which are given in the paper.

13652 s- AND p-WAVE NEUTRON SPECTROSCOPY. V. LEVEL SPACINGS IN HEAVY NUCLEI.

H.W.Newson, J.H.Gibbons, H.Marshak, E.G.Bilpuch, R.H.Rohrer and P.Capp.
Ann. Phys. (USA), Vol. 14, No. 1, 346-64 (July, 1961).

For Pt IV, see Abstr. 5788 of 1960. Total neutron cross-sections were measured for natural rubidium and thallium and for the separated isotopes, Pb^{208}, Pb^{207}, Pb^{206}, Tl^{203}, and Rb^{85}. Approximate s-wave resonance spacings were estimated for Pb^{207}, Y^{89}, Rb^{87} Rb^{85}, Tl^{203}, and Tl^{205}. $D_0 = D_J(2J + 1) = 2D_S(2I + 1) = 50, 24, 8, 4,$ and 30 keV, respectively, where D_S is the average (s-wave) level spacing for all channels. The spacings (D_0) of Pb^{206} and Pb^{208} were found to be of the order of hundreds of keV; there is also evidence that resonance spacings are very wide for Sr^{86} and Ba^{136}. It is concluded that, in all compound nuclei with a neutron number slightly less than the magic numbers 50, 82, and 126, the resonance spacings are usually not much less than when the magic number is exceeded slightly. Since neutron excitation energies of these sub-magic nuclei are higher than the average, the observed wide level spacings below the magic numbers must be due to the properties of the nearly closed shells and cannot possibly be caused only by low excitation energy of the compound nucleus. In considering these comparisons it is shown that, for s-wave resonances, the relation $D_J = D_0/(2J + 1)$ is a useful approximation in that a plot of D_0 is a much less erratic function of A than is the observed spacing. The Bethe—Hurwitz effect is also discussed, i.e. the influence on resonance spacing (apart from the 2J + 1 factor) of an unpaired nucleon in the target nucleus. It is estimated that $\alpha \gtrsim 30$ in the equation $D_0(0)/D_0(W) = = \exp(\alpha W)^{1/2}$ where $D_0(0)$ is the energy and spin-independent spacing parameter, and W is the excitation energy of the compound nucleus.

13653 s- AND p-WAVE NEUTRON SPECTROSCOPY. VI. LEVEL DENSITY AND NEUTRON EXCESS.

H.W.Newson, E.G.Bilpuch, F.P.Karriker, L.W.Weston, J.R.Patterson and C.D.Bowman.
Ann. Phys. (USA), Vol. 14, No. 1, 365-86 (July, 1961).

For Pt V, see preceding abstract. Neutron total cross-section curves for Ca^{40}, Ca^{44}, Cr^{50}, Cr^{52}, Cr^{54}, Fe^{54} and natural Fe, Ti, and Cr were measured in the keV region. Level spacings were estimated for the predominant isotope in each of the samples measured, and are compared to similar data found for even N, odd Z targets. After correcting for differences in the angular momenta and excitation energies, it is found that on the average (between A = 35 and 60) $d[\ln D_0(6\ \mathrm{MeV})] = (\partial \ln D_0/\partial Z)dZ + (\partial \ln D_0/\partial N)\,dN \cong 0.3\,dZ - 0.3\,dN$, and hence $D_0(6\ \mathrm{MeV})$ is proportional to $\exp -0.3(N-Z)$. $D_0(6\ \mathrm{MeV})$ is the spin and energy-independent spacing parameter. Except for slight signs of a maximum at N = 28, D_0 (6 MeV) appears (between A = 35 and 60) to be strongly dependent only on the neutron excess, N—Z, and not on N, Z, or A; uncertainties in the correction for excitation are such that it is likely that the absolute value of the exponent, 0.3 (N—Z) is a lower limit. Isotopic and J^{π} assignments of many resonances in the natural fluorine and chromium cross-section curves are suggested.

13654 s- AND p-WAVE NEUTRON SPECTROSCOPY. VII. WIDTHS OF NEUTRON RESONANCES.

E.G.Bilpuch, K.K.Seth, C.D.Bowman, R.H.Tabony, R.C.Smith and H.W.Newson.
Ann. Phys. (USA), Vol. 14, No. 1, 387-418 (July, 1961).

Neutron reduced widths Γ_n^0 and Γ_n^1 are reported for about 200 resonances observed in neutron total cross-sections of $Ca^{40,44}$, Ti^{48}, $Cr^{50,52,54}$, $Fe^{54,56}$, $Ni^{58,60}$, Sr^{88}, Y^{89}, Sn^{124}, Te^{130}, $Ba^{136,138}$, and $Pb^{206,207,208}$, in the energy region 1 to 200 keV. Average parameters $\bar{\Gamma}_n^0$, $\bar{\Gamma}_n^0/D$, and $\bar{\Gamma}_n{}^1/D$ have been derived and the Wigner distribution for local spacings and the Porter—Thomas distribution for reduced widths are verified for the resonances in the even—even nuclei Ca^{40}, Fe^{56}, Ni^{58}, and Ni^{60}. A simple method of area analysis which is less tedious and time consuming than the method reported before in Pt III is also described.

13655 THE ASYMMETRY OF THE 3 MeV EXCITED STATE OF Be^8, OBTAINED THROUGH Li^8 FORMED AT HIGH ENERGY INTERACTIONS.

R.Stein, H.Braun and P.Cüer.
J. Phys. Radium (France), Vol. 21, No. 5, 374-5 (May, 1960).
In French.

Low and Mean Energy, Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). A study of the energy levels involved in the reaction $Li^8_3 \rightarrow Be^8_4 \rightarrow 2\alpha$ shows the 3 MeV level to be asymmetrical. The measurements were made on individual α-particles emitted in the disintegration of Be^8. It seems that there is also an angular anisotropy between the Li^8 fragment and the α-particles.

13656 LOW-ENERGY GAMMA TRANSITION IN Eu^{153}.

A.Moussa and E.Monnand.
J. Phys. Radium (France), Vol. 21, No. 5, 463 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The internal conversion lines decay $Sm^{153} \rightarrow Eu^{153}$ were studied with a double focusing magnet spectrometer. The 19 keV transition between the 103 and 84 ke levels is revealed by its L conversion lines and is classified as E2. The M1 + E2 mixtures in the 69 and 103 keV transitions w determined by analysis of their L conversion lines.

13657 AN ENERGY LEVEL OF ^{24}Mg AT 6.44 MeV EXCIT TION.

S.Hinds, R.Middleton and A.E.Litherland.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1211-14 (June, 1961).

The α-particles from the reaction $C^{12}(O^{16},\alpha)Mg^{24}$ were obs with a multichannel spectrograph. In addition to the levels of previously observed in the $Na^{23}(He^3,d)Mg^{24}$ reaction, new levels observed at 6.44, 11.08 and 11.73 MeV. L.L.

13658 THE SPIN OF A NEW LEVEL IN ^{24}Mg.

C.Broude and H.E.Gove.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1211-14 (June, 1961).

In the inelastic scattering of protons by Mg^{24}, a 5.07 MeV is observed in coincidence with a 1.37 MeV γ-ray, indicating a level in Mg^{24} at 6.44 MeV. Correlation experiments on these γ indicate that the 6.44 MeV level has spin zero. L.L.

13659 A STUDY OF LOW-LYING EXCITED STATES IN Mn^{56} AND Ho^{166} BY MEASURING CASCADE QUANT COINCIDENCES.

A.S.Melioranskii, I.V.Éstulin and L.F.Kalin
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 64-71 (Jan., 196
In Russian.

The technique for the measurement of the intensity of casc γ-quanta was employed to investigate the low-lying levels of th odd—odd nuclei Mn^{56} and Ho^{166}. The multipolarity of the 25 and 85 keV radiative transitions in Mn^{56} was determined. The leve scheme of the strongly deformed Ho^{166} nucleus, which exhibits rotational band, is discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 43-9 (July, 1961)].

13660 ROTATIONAL BANDS IN Ne^{20}.

A.E.Litherland, J.A.Kuehner, H.E.Gove, M.A.Clar and E.Almqvist.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 98-100 (Aug. 1, 1961).

The experimental data on the levels of Ne^{20} is summarize It is pointed out that the level spectrum of Ne^{20} may be separa into a series of rotational bands. L.L.

13661 0^+ SECOND EXCITED STATE OF ^{32}S.

T.Wakatsuki, Y.Hirao, E.Okada and I.Miura.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 918-20 (Oct., 1960

The second excited state of S^{32} at 3.78 MeV has previously assigned 1^+ on the basis of a $l = 0$ assignment in the $P^{31}(d, n)S$ action and the observation of the γ-decay to the 0^+ ground stat is shown that this 3.8 MeV γ-ray is not due to the transition fr second excited state. γ-ray correlation measurements also s an assignment of 0^+ for this level. L.L.

13662 EXCITED LEVELS OF Sn^{116}.

J.Colard, P.Gepts, L.Grenacs, A.Jones and P.Lipn
J. Phys. Radium (France), Vol. 21, No. 12, 863-9 (Dec., 1960).
In French.

The β—γ coincidences confirmed the main features of the generally accepted scheme. Measurements of the slow γ—γ c cidences revealed the existence of the 1 756 keV transition. T internal conversion method indicates J = 4 and positive parity 2535 keV level. On the other hand the same measurements pr the absence of isomeric transition in In^{116} between the isomeri levels of 54 min and 13 sec, having an intensity in excess of 0.

13663 ENERGY LEVELS OF Zn^{65}.

A.K.Val'ter, I.I.Zalyubovs'kўi, O.P.Klucharyev and V.P.Lutzўk.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 46-51 (1959). In Ukrai

The γ-transitions were studied by investigating the $Cu^{65}(p,n\gamma)\ Zn^{65}$ and $Zn^{64}(p,\gamma)\ Ga^{65}$ reactions, which result in th residual Zn^{65} nucleus as that after the decay of Ga^{65}. The ener level scheme of Ga^{65} was established in accordance with both reactions. The half-life of Ga^{65} was measured and its decay s determined.

NUCLEAR DECAY RADIOACTIVITY

64 APPLICATIONS OF RADIOACTIVE ELEMENTS USING NEW APPARATUS.

eque, P.Martinelli and J.C.Tanguy.
r Electronics Conference, Paris, 1958, Vol. II (see Abstr. of 1960) p. 361-5. In French.

aree detecting devices for use with industrial radioactive s are described. One is a detector without a time constant, tecting the passage of rapidly moving objects by means of a carried by the object. A signal is only given if a predeterm- umber of pulses arrive in a time t. The pulses are fed to a scaler which operates a relay. A simple detector with a counter is used to locate a scraper which may have stopped pe line. A radioactive source is also used to measure the ess of a metallic deposit, by exciting the characteristic s of the metal, which are analysed in a proportional counter.

W.G.Stripp

665 NOMENCLATURE FOR STANDARDS OF RADIOACTIVITY. A.G.McNish.

at. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, (July, 1960).

he system involves a two-dimensional classification into ries and orders. The categories indicate the nature and use standards and the order indicate the "authority" of the ards of each kind.

666 SPECIFIC-ACTIVITY NOMOGRAMS.

T.A.Eastwood.

onics (USA), Vol. 19, No. 1, 64 (Jan., 1961).

ucleonics Data Sheet No. 39. A nomogram relating the ic activity of a pure radionuclide to its half-life and atomic t.

R.D.Smith

667 ISOTOPE CALCULATIONS. PARENT ACTIVITY FROM DAUGHTER GROWTH. Y.Marcus.

onics (USA), Vol. 19, No. 3, 76 (March, 1961).

ucleonics Data Sheet No. 41. A curve-fitting method appli- to long-lived radionuclides with short-half-life daughters. By uring and plotting the growth of the daughter from the separated t, an accurate value of equilibrium activity and the time of ation, and an approximate value for the half-life of the ter can be found.

R.D.Smith

668 A HIGH INTENSITY CESIUM-137 RESEARCH IRRADIATOR. R.C.Palmer and R.W.Carter.

nat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4, (Dec., 1960).

The design, installation and calibration of a 12 000 c Cs^{137} arch irradiator of the Notre Dame type has been completed at eorgia Institute of Technology. The dose rates are 1.4×10^6 hr in the centre sample hole and 1×10^6 rad/hr in the outer le holes.

3669 A METHOD FOR CURVE-FITTING BY EXPONENTIAL FUNCTIONS. W.Perl.

nat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 211-22 ., 1960).

A method is presented for fitting exponential functions to data of lecay type. In an elementary "peeling-off" form of the method, ocal ordinate is plotted against the local first derivative of the . The straight line portion of this graph at large time, if it ts, yields simultaneously a constant (asymptotic value) plus an nential, which can be subtracted from the given curve and the edure repeated. The method permits judging the data in simple ion for suitability of fit by exponentials simultaneously with the g itself. The method is formulated as an analytic version of y's method, which permits clarification of certain difficulties e latter. Procedures are suggested for fitting exponentials with ely spaced half-lives, and for fitting functions other than expon- al. The method is illustrated by application to data on the time se of respiratory uptake of a highly fat-soluble inert gas by an subjects.

3670 A LOW-BACKGROUND LABORATORY.

H.W.Wilson, D.E.Watt and D.Ramsden.

rnat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 158-66 ., 1961).

Consideration of the design, cost and construction of a low-background laboratory for the measurement of low specific activity samples leads to the choice of demineralized water as the main shielding material. Background figures and spectra obtained for a range of proportional and scintillation counters in the completed laboratory, show that the shielding is slightly better than 12 in. of steel. It is deduced from energy and intensity measurements that the gamma-ray peaks occurring in the background spectrum arise mainly from ThC" present in the counter construction materials.

13671 DESIGN STUDIES FOR A Cs-137 IRRADIATOR.

D.O.Cummins and C.F.G.Delaney.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 106-11 (April, 1961).

Design studies for a 600 c caesium irradiator for genetic experiments are described. The six source rods, arranged in a cylinder around the sample, can be moved in and out on an iris diaphragm arrangement so as to give varying intensities at the sample. The distribution of the discrete sources contained in the rods is discussed in detail, with a view to providing the maximum flux uniformly throughout the sample to be irradiated. A low-activity mock-up was used to arrive at an arrangement which was appreciably better than a uniform distribution of sources along the rods. A twelve rod system is also briefly discussed.

13672 SELF-ABSORPTION OF CARBON-14 SAMPLES ON THIN PAPER PLANCHETS. E.R.Powsner.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 22-9 (Feb., 1961).

Using carbon-14 samples absorbed on thin paper disks, the apparent radioactivity was measured in a gas-flow counter over a wide range of specimen thickness. Results shown that specimens ranging up to a thickness of 150 $\mu g/cm^2$ may be regarded as approximately infinitely thin. It is estimated that the count rate is decreased by approximately 20% as a result of absorption of the radioactivity by the paper. To a considerable extent, the change in count rate due to self-absorption varies as the reciprocal of a linear function of the thickness of both the paper and the specimen.

13673 THE PREPARATION OF THIN SOURCES OF S^{35} AND ITS STUDY AT VERY LOW ENERGIES. A.Juillard.

J. Phys. Radium (France), Vol. 21, No. 5, 467-9 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Techniques are described for obtaining very thin S^{35} sources, of good specific activity and stable under vacuum. The low energy β spectrum permits the determination of transmission curves of counter windows and preacceleration corrections. The comparative study of various sources supplies evidence on the deformation of the spectrum at very low energies.

13674 MAXIMIZING PRODUCTION OF RADIOISOTOPES IN A CYCLOTRON. F.L.Green and J.A.Martin.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 387-91 (April, 1960).

The radioisotopes Mn^{54}, I^{125}, and I^{130} were produced at higher rates and at lower cost when targets of isotopically enriched Cr^{54}, Te^{125}, and Te^{130} were bombarded with protons in the ORNL 86 in. cyclotron. The product isotopes were carrier-free and also relatively free of undesired radioisotopes. The use of enriched isotopes as cyclotron targets is economically attractive when the target material can be recovered and reused. To obtain the maximum production rate for radioisotopes in a cyclotron, both the usable beam power and the excitation function of the nuclear reaction must be considered; in some cases the maximum rate is achieved at a reduced energy. With the ORNL cyclotron (p, n) reaction production rates were increased by a factor of 1.7 by decreasing the proton energy from 22 to 18 MeV and doubling the output current. Methods of reducing the energy below the maximum design value are discussed.

13675 A SIMPLE METHOD FOR THE DIFFERENTIAL COUNTING OF RADIOACTIVE IRON (Fe^{59}) AND CHROMIUM-51 IN MIXTURES.

L.A.Walker, G.Sparling and H.Mercer.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 17-21 (Feb., 1961).

A method is described for the accurate counting of Cr^{51} and Fe^{59} in mixtures containing both isotopes. This method makes use of only a scintillation counter and associated scaler. Neither lead filters nor gamma-ray spectrometer is needed, and the accuracy is as good as that of either of the other two methods.

13676 THE USES OF RADIO-ACTIVE ISOTOPES IN NON-DESTRUCTIVE TESTING. J.F.Cameron.

Progress in non-destructive testing, Vol. 2 (see Abstr. 9239 of 1961) p. 91-164.

The basic principles of radioisotope techniques are outlined, and the types of measurement to which they are applicable are illustrated by numerous practical examples. The topics discussed include radioactive thickness gauges, tracer applications, analytical techniques and safety considerations. 199 references. J.B.Birks

13677 THE USE OF ION-EXCHANGE METHODS FOR THE EXTRACTION OF RADIOACTIVE FISSION PRODUCTS FROM FALL-OUT. D.Dunkel.

Atomkernenergie (Germany), Vol. 5, No. 5, (May, 1960). In German.

Radioactive substances in atmospheric fall-out are detected more successfully by means of ion-exchange than by the boiling method. Systematic investigations show that most of the dissolved radioactive ions are alkaline earths. Rare earths and heavy metals contribute only a few percent to the dissolved activity. With this fact, special decay curves are quantitatively described.

13678 RESULTS OF THREE-YEAR SYSTEMATIC MEASUREMENT OF NUCLEAR FALL-OUT. V.Santholzer.

Czech J. Phys., Vol. 10, No. 8, 595-601 (1960).

A survey is given of the results of measuring the radioactivity of rain-out from November 1, 1956 to February 1, 1960, and of fall-out from November 1, 1958 to February 1, 1960. The temporary cessation of nuclear weapon tests from November 1958 became apparent in the second half-year after the cessation by a decrease in the cumulative activity to 45% of the value for the first half-year. At the end of 1959 another decrease was apparent. It was shown on the basis of long-term investigation into the activity that the samples of fall-out with greater activity contain relatively very little admixture from earlier nuclear tests so that in the period of a few weeks to months the sets of fission products may be regarded as practically isolated. The exponent n in the relation $A = at^{-n}$ is most frequently 1.2 for the period of the first four months and for older samples is most often n = 1.5. The energy of the beta and gamma rays from fall-out was estimated on the basis of absorption measurements. It was shown that the quality of the beta radiation varies with the age of the samples. A brief survey is given of the results of determining the Sr^{90} content in fall-out and milk, and of the physical methods used to determine the Sr^{90}.

13679 INVESTIGATIONS INTO THE LOW ENERGY GAMMA RAY BACKGROUND AND ITS VARIATIONS.

B.Roy, P.K.Sandell and A.K.Choudhury.

Indian J. Phys., Vol. 35, No. 2, 77-85 (Feb., 1961).

The gamma-ray background of Calcutta as determined by scintillation spectrometry using a thallium-activated NaI crystal consists of two broad energy bands being contributed by the radioactive substances present in the soil, air and building materials and identified as those from the radium and thorium family. The background so determined indicates that there are two possible regions of low-level counting which is achieved by choosing an optimum channel-level and channel-width. The variation in intensity of the background is restricted mostly to the lower energy region of the background spectrum.

13680 INVESTIGATIONS OF THE RADIOISOTOPES Be^7, P^{32}, AND S^{35} IN RAIN WATER. Rama.

J. geophys. Res. (USA), Vol. 65, No. 11, 3773-6 (Nov., 1960).

The concentration of the radioisotopes Be^7, P^{32}, and S^{35} in rainfall at Bombay and at Kodaikanal were measured. The average concentrations in rainfall at Bombay during the period from June 1959 to October 1959 were 2900 atoms/ml of Be^7, 12 atoms/ml of P^{32}, and about 400 atoms/ml of S^{35}. It is shown that the observed fallout of Be^7 and of P^{32} is almost entirely of cosmic-ray origin; the fallout of S^{35} may possibly contain an appreciable amount of bomb-produced S^{35}.

13681 CHLORINE-36 RADIOACTIVITY IN RAIN.

O.A.Schaeffer, S.O.Thompson and N.L.Lark.

J. geophys. Res. (USA), Vol. 65, No. 12, 4013-16 (Dec., 1960).

Cosmic rays and nuclear explosions are adding radioactivity to the atmosphere from which it is then removed by rainfall. The investigation of these activities furnishes a means of obtaining new information of significance in geological problems as well as in the understanding of the hazards of nuclear fallout. Cl^{36} is an interesting isotope for such a study as it has a relatively long h life, 308 000 years, and at the same time is very soluble in wate Relatively high levels of Cl^{36} activity were found in rain. The le are several orders of magnitude above the level to be expected from cosmic-ray production. The Cl^{36} is almost surely the resu of neutron irradiation of sea water by nuclear explosions.

13682 ON THE SPRING MAXIMUM OF RADIOACTIVE FA OUT FROM NUCLEAR TEST EXPLOSIONS.

J.F.Bleichrodt, J.Blok and R.H.Dekker.

J. geophys. Res. (USA), Vol. 66, No. 1, 135-41 (Jan., 1961).

Some results of measurements are presented pertaining to maximum of fallout which was observed during the spring of the last few years. Evidence is presented that the height of this ma mum is chiefly determined by the amount of radioactive debris present in the temperate or polar lower stratosphere, whereas seasonal factors determine the time of appearance of the maxim

13683 THE PREPARATION OF KRYPTON-85—CLATHRAT COMPOUNDS. E.J.Wilson and J.D.H.Hughes.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4, 12 (Dec., 1960).

13684 NUCLEAR ALINEMENT OF COBALT AND THE DECAY OF COBALT-55.

C.J.S.Chapman, J.M.Gregory, R.W.Hill and M.W.Johns.

Proc. Roy. Soc. A (GB), Vol. 262, 541-54 (Aug. 8, 1961).

Cobalt-55 was aligned in a crystal of nickel zinc fluosilicat which was magnetically cooled to 0.004°K, and the anisotropy o 0.935 and 1.41 MeV radiations studied as a function of temperat On the assumption that the spin of Co^{55} is $\frac{7}{2}$, the spins of the 0, 0.935 and 1.41 MeV levels in Fe^{55} are $\frac{3}{2}$, $\frac{5}{2}$ and $\frac{7}{2}$ respectively with presumably odd parity; the 0.935 MeV γ-ray is a dipole-quadrupole mixture with $\delta = +0.37 \pm 0.04$. The magnetic mome of Co^{55} is 4.3 ± 0.3 n.m. and the Fermi admixture in the β-transition to the 1.41 MeV level of Fe^{55} is less than 10%. Th crystals used consisted of an inactive core on to which a layer several millimetres thick and containing the cobalt activity (Co^{55}, Co^{56}, Co^{58} or Co^{60}) was grown. Data concerning the effe of the nickel concentration in the active layer on the cooling properties of such crystals are presented. The rapidity and ea with which these crystals may be grown should make the techni applicable to isotopes with half-lives as short as 10 hr. New da on the Co^{58} alignment indicates that a Fermi admixture of 1 ± 1% is associated with the β-transition.

13685 THE LIFETIME OF HYPERFRAGMENTS.

G.C.Deka.

Indian J. Phys., Vol. 34, No. 10, 470-4 (Oct., 1960).

Available data on the time-of-flight of hyperfragments have been used to deduce a lifetime for light hypernuclei, and the val thus obtained is discussed.

13686 NEW SHORT PERIOD ISOTOPES OBTAINED BY G SPALLATION. G.Albouy, M.M.Gusakow and N.Poff

J. Phys. Radium (France), Vol. 21, No. 10, 751-3 (Oct., 1960). In French.

By means of double electromagnetic separation, Hg^{185-90} is and their daughters were determined in Au spallation reactions. special arrangement permitted observation of the short-period isotopes of masses 185-7. By means of γ-ray spectrum analys and decomposition of decay curves the half-life of the Hg-isotop and of their daughters were determined as well as the principal γ-ray energies with which they are associated. The results are discussed. The effect of the mass number variation on the half-life was studied by suitable curves showing in the case of Hg a regular decrease of the half-life with no influence of the mass number parity, while in the case of Au the neutron-deficient isotopes have longer half-lives (by analogy) than the corresponding isotopes. L.Mord

13687 DETERMINATION OF THE HALF-LIFE OF Au^{198} B CALORIMETER. J.Robert.

J. Phys. Radium (France), Vol. 21, No. 11, 808 (Nov., 1960). In French.

A value of 2.699 ± 0.004 days was obtained for the half-life Au^{198}, using an adiabatic microcalorimeter. No contamination of Au^{199} and other isotopes was measurable. R.H.Tho

688

THE LIFETIME OF A METASTABLE STATE OF PROACTINIUM 233.

A.Marchal and P.Ivon.

Acad. Sci. (France), Vol. 252, No. 24, 3774-5 (June 12, 1961).
nch.

he lifetime of the 87 keV level of Pa^{233} was measured as
0·5 nsec. R.H.Thomas

689

DECAY PERIOD OF Zn^{65}.

I.I.Agîrbiceanu and V.Tatu.

Acad. Sci. (France), Vol. 252, No. 25, 3979 (June 19, 1961).
nch.

he measurement was made using a spectrographic technique.
e of $T_{1/2}$ = (249.7 ± 1.4) days was obtained, which is different
the more accurate values obtained earlier. J.B.Garg

690

SHORT-LIVED ISOMERS OF Ga, Ge AND As PRODUCED BY 19.2 MeV PROTONS.

A.M.Morozov.

ksper. teor. Fiz. (USSR), Vol. 40, No. 1, 101-4 (Jan., 1961).
ssian.

mproved data are presented relating to the short-lived
rs previously observed when Ga, Ge and As were irradiated
ast protons (See Abstr. 8122 of 1957; 1382 of 1960). A more
ed investigation revealed two short-lived activities in
anium, one of which is produced in the reaction Ge^{76} (p, 2n)
and the other apparently in Ge^{72} (p, pn)Ge^{71m}. The
eric activities which followed the bombardment of gallium and
ic were shown to result from Ga^{71} (p, n)Ge^{71m} and As^{75}
)As^{75m}, respectively. The energy dependence of the cross-
ons for Ga^{71} (p, n)Ge^{71m} and Ge^{76} (p, 2n)As^{75m} were measured
the reaction threshold to 19.2 MeV. [English translation in:
t Physics—JETP (USA), Vol. 13, No. 1, 72-4 (July, 1961)].

3691

NUCLEAR SHAPE EFFECT ON ISOMERIC SHIFT [IN In^{115} III AND Hg^{197}].

J.Lardinois.

ys. Radium (France), Vol. 21, No. 5, 451 (May, 1960).
ench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble,
(see Abstr. 12029 of 1961). See Abstr. 7721 of 1960.

3692

NUCLEAR ISOMERISM IN In^{116}.

P.H.Heckmann, K.Gubernator, J.Pöyhönen and
ammersfeld.

hys. (Germany), Vol. 163, No. 4, 451-56 (1961). In German.

The short-lived indium isomer produced by thermal neutron
re is confirmed to be In^{116}. New determinations of half-life
-energy yield $T_{1/2}$ = (2·17 ± 0·07) sec and E_{γ} = (164 ± 1) keV.
surement of the K-shell conversion coefficient shows that the
ipolarity of the transition is E3, leading to a spin and parity
gnment of 8$^-$ for the isomeric level.

3693

A SEARCH FOR AN ISOMERIC STATE IN Mn^{54}.

O.Dietzsch, R.A.Douglas and V.Gomes.

lear Phys. (Internat.), Vol. 26, No. 1, 113-16 (July, 1961).

An attempt was made to detect the 2 min isomeric state in
reported by Caldwell and Stoddart [Phys. Rev. (USA), Vol. 81,
(1951)] and by Elwyn et al. (Abstr. 6108 of 1959). A study has
made of activities following the gamma-irradiation of Mn^{55}
ets and the proton bombardment of a natural chromium target.
ctivity with half-life 2 ± 1.5 min was found which could be
ibuted to Mn^{54}. From these experiments it is concluded that
e is insufficient evidence to establish the existence of the iso-
ic state in Mn^{54}.

13694

DECAY SCHEME OF Te^{131m}.

A.Bădescu, O.M.Kalinkina, K.P.Mitrofanov, A.A.Sorokin,
.Forafontov and V.S.Shpinel'.

eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 91-100 (Jan., 1961).
ussian.

The γ- and β-radiation accompanying the decay of the Te^{131m}
ner ($T_{1/2}$ = 30 hr) was measured with a scintillation γ-coinci-
ce spectrometer, a two-lens β-spectrometer and a βγ-coinci-
ce spectrometer. A decay scheme for Te^{131m} is proposed.
els at 0.15, 0.60, 0.78, 0.92, 1.62, 1.82, 1.92, 2.00 and 2.24 MeV
e been established for the daughter nucleus I^{131}. The spins and
ities of a number of levels have been determined from the data
he multipolarities and relative intensities of the γ- and β-trans-
ns. [English translation in: Soviet Physics—JETP (USA),
. 13, No. 1, 65-71 (July, 1961)].

13695

ON FAVOURED ALPHA TRANSITIONS.

A.Săndulescu and M.Iosifescu.

Nuclear Phys. (Internat.), Vol. 26, No. 2, 209-16 (Aug., 1961).

Using the collective model in the strong coupling scheme, it is established that the reduced width of a favoured α-transition with single angular momentum for an odd-mass nucleus of mass number A is proportional to the reduced width of the favoured α-transition with the same angular momentum for the even—even nucleus A − 1, if both nuclei have the same deformation. This makes it possible to express the α-intensities of odd-mass nuclei in terms of the reduced widths of the α-transitions in even—even nuclei. Values of the latter widths extracted by Rasmussen (Abstr. 7322 of 1959; 1383 of 1960) from experimental data were used to calculate intensities of favoured α-transitions of odd-mass nuclei and relative intensities of their components of given angular momentum. The theoretical results are in good agreement with experimental data.

13696

A MODEL OF α-DECAY CONSISTENT WITH α-REACTIONS.

J.Osada, D.R.de Oliveira, N.Martins and T.Miyazima.

Nuovo Cimento (Italy), Vol. 20, No. 5, 845-56 (June 1, 1961).

A new model of α-decay is presented which is consistent with such α-reactions as (p, α). Both the α-decay and the direct α-reaction suggest that with a certain probability α-particles exist in the nuclear surface. According to the current theories of α-decay the α formation probability turns out very small, of the order of magnitude 10^{-4} while, from the analysis of (p, α) reactions the α probability is estimated to be of the order of magnitude of several times 0.1. Although there may be some difference in the physical meanings of the α probabilities in the two cases, there are enough reasons to believe they are of the same order of magnitude. In the authors' model α-particles are assumed to be constantly formed within the nuclear matter and to go out into the nuclear surface where most of them are reflected back or destroyed and some of them go out into the outer space. Besides this specific mechanism, use has been made of as much experimental data as possible and the above mentioned discrepancy and some systemic tendencies in the α-decay isotopes are explained on a unified basis.

13697

PENETRATION FACTOR IN ALPHA-DECAY.

S.K.Dutta, T.K.Mitra and N.C.Sil.

Indian J. Phys., Vol. 34, No. 5, 205-10 (May, 1960).

The penetration probability of α-particles through a potential barrier is calculated using the Lanczos method of solving the Schrödinger equation near the nuclear boundary. The Woods—Saxon potential for the nuclear field is used. The value of the half-life of Po^{214} calculated from this penetration factor comes out to be twice the experimental value.

13698

A GENERAL TREATMENT OF PENETRATION FACTOR IN ALPHA-DECAY.

S.K.Dutta.

Indian J. Phys., Vol. 35, No. 6, 299-306 (June, 1961).

A general treatment of the calculation of the penetration probability of α-particles through a potential barrier of Woods—Saxon diffuse type nuclear potential along with the Coulomb potential is given according to the one-body model for arbitrary values of the angular momentum of the emitted α-particles. In the region where practically only the Coulomb potential is present the rigorous solution of Schrödinger equation is taken from that of Abramowitz (Abstr. 5853 of 1949). Near the nuclear boundary where both the potentials operate, the Schrödinger equation is solved by an ingenious method due to Lanczos (1938).

13699

ALPHA-PARTICLE DECAY OF THE 15.1 MeV STATE IN ^{12}C.

G.L.Miller, R.E.Pixley and R.E.Segel.

Proc. Roy. Soc. A (GB), Vol. 259, 275-84 (Dec. 6, 1960).

A search was carried out for the α-particle decay of the 15.1 MeV state in C^{12}. The state was made by the B^{10}(He^3, p)C^{12} reaction. The protons feeding the 15.1 MeV state were seen in proton singles spectra and in coincidence with 15.1 MeV γ-rays, but none were seen in coincidence with α-particles. Comparison with a nearby state known to decay virtually solely by α-particles established that the 15.1 MeV state α-decays less than 20% of the time. Combining this result with the results of γ-ray resonance scattering it is found that $\Gamma_{\alpha} < 15$ eV. The sensitivity of the experiment was limited by a continuum from the break-up of the B^{10} + He^3 system.

13700 NEW ELEMENT, LAWRENCIUM, ATOMIC NUMBER 103. A.Ghiorso, T.Sikkeland, A.E.Larsh and R.M.Latimer.
Phys. Rev. Letters (USA), Vol. 6, No. 9, 473-5 (May 1, 1961).

A 3 μg target of californium on a nickel foil was bombarded with a beam of B^{10} or B^{11} ions. Active products of the reactions recoiled into a helium atmosphere, and were collected on a thin copper conveyor tape; their α-spectra were measured using several gold-silicon solid-state counters. An α-activity with a half-life of 8 ± 2 sec and energy 8.6 MeV was observed and attributed to a new element to be called Lawrencium (symbol Lw), of atomic number 103. The isotope concerned is believed to have a mass number 257. Also observed in the spectrum are α-rays of energy 8.4 and 8.2 MeV with half-lives ~15 sec, probably due to element 102. Detailed evidence for the assignment of the 8.6 MeV activity is discussed. R.E.Meads

13701 DISINTEGRATION SPECTRUM OF Li^8. CALIBRATION OF THE BUCHNER SPECTROMETER OF THE CRONENBOURG VAN DE GRAAFF. R.Bilwes, R.Seltz, M.Suffert, C.Gérardin, J.Linck, D.Magnac-Valette and P.Cüer.
J. Phys. Radium (France), Vol. 21, No. 5, 376-7 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The deuteron beam of the Strasbourg 6 MeV Van de Graaff accelerator was used to produce Li^8 nuclei in the reaction $Li^7(d,p)Li^8$. A special design of the target assembly is described which only allows particles coming from the disintegration of Li^8 to be recorded, on an Ilford E1 nuclear track plate. The only clear maximum corresponds to the 3 MeV level of Be^8. This level is asymmetrical, with a long tail on the high energy side, up to 10 MeV, according to phase shift measurements of α—α scattering.

ENERGY OF ALPHA-PARTICLES EMITTED BY Po^{210}.
See Abstr. 13798

13702 THE DETERMINATION OF THE HALF-LIFE OF RaC'. T.Dobrowolski and J.Young.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1219-20 (June, 1961).

The half-life of RaC' formed by β-decay of RaC and decaying by α-emission to RaD, was measured by determining the time distribution of these α-particles relative to the β-particles, which provide the zero time signal. A thin foil upon which Ra was deposited was placed between two proportional counters—one sensitive to α, the other sensitive to β, both coupled to a time analyser (9 channels of 50 μsec, controlled by a crystal oscillator through a beam switching tube). Due to the short half-life a delay of 1.2 msec after the zero time signal enabled measurement of the α background. The half-life measured by this method, and by an analysis by a least squares fit to a pure exponential plus a constant background, gave a mean value of 164.3 ± 1.8 μsec, in good accord with literature. L.Mordecai

13703 ON THE NATURAL RADIOACTIVITY OF SAMARIUM. M.Karras.
Ann. Acad. Sci. Fennicae A VI (Finland), No. 65, 30 pp.(1960).

The half-lives and the energies of α-particles of the radioactive isotopes of Samarium were measured with the help of two gridded ionization chambers. The samples used were natural Samarium and enriched isotopes of Sm^{148} and Sm^{149}. The following results were obtained:

Isotope	E_α (MeV)	$T_{1/2}$ (Years)
Sm^{147}	2.20 ± 0.02	$(1.17 \pm 0.05).10^{11}$
Sm^{148}	2.14 ± 0.03	$(1.2 \pm 0.3).10^{13}$
Sm^{149}	1.84 ± 0.05	$(4 \pm 2).10^{14}$

J.B.Garg

13704 THE BRANCHING RATIO OF THORIUM C (Bi^{212}). J.G.Ferriera, M.T.Gonçalves and L.Ferreira-Salgueiro.
C. R. Acad. Sci. (France), Vol. 253, No. 1, 98-9 (July 3, 1961).
In French.

Reports a new value of the branching ratio in the decay of ThC. The ratio for the α and β decay modes is:-

$$\frac{\alpha}{\alpha+\beta} = 0.351 \pm 0.006.$$

R.H.Thomas

13705 SOME LEVELS OBTAINED IN THE COURSE OF T
ALPHA DISINTEGRATION OF Th^{227}_{90} (RaAc). G.Y.
J. Phys. Radium (France), Vol. 21, No. 5, 447-8 (May, 1960).

Low and Mean Energy Nuclear Physics Colloquium, Gren
1960 (see Abstr. 12029 of 1961). The following spin and pariti
are proposed for the disintegration cascade:

$$Th^{227}(\text{ground state}, {}^3\!/\!_2+) \xrightarrow[5744\ \text{keV}]{\alpha} Ra^{223}(286\ \text{keV level}, {}^3\!/\!_2+) \xrightarrow[236]{\gamma}$$

$$Ra^{223}(50\ \text{keV level}, {}^3\!/\!_2-) \xrightarrow[50\ \text{keV}]{\gamma} Ra^{223}\ (\text{ground state}, {}^1\!/\!_2+)$$

13706 ON THE SHAPES OF ALLOWED BETA SPECTRA.
B.Kuchowicz.
Acta phys. Polon. (Poland), Vol. 20, No. 4, 341-9 (1961).

A discussion of the small deviations observed in the beta
spectra. No explanation thereof exists within the framework o
conventional theory, even assuming the usually dominating nuc
matrix element to be suppressed. Two alternative explanation
the phenomenon are discussed, both of which are tentative. On
ascribes the effect to G-nonconserving interactions; the other
attributes the deviations to a virtual intermediary helical spin
boson.

13707 EFFECT OF WINDOW ABSORPTION AND SOURC
BACKING ON β-SPECTRA. B.N. Subba Rao.
Proc. Indian Acad. Sci. A, Vol. 51, No. 1, 28-33 (Jan., 1960).

Estimates of the distortive effects of window absorption a
backscattering from source backings on β-spectra are present
as observed in the intermediate-image β-ray spectrometer. T
existence of a scatter-initiating thickness is pointed out and
explained. These correction factors are applied to the β-spec
of Pm^{147} to estimate their validity.

13708 STUDY OF THE EMISSION OF ELECTRONS ACC
PANIED BY β- AND α-RADIOACTIVITY BY THE
COINCIDENCE TECHNIQUE. M.Duquesne.
Ann. Phys. (France), Vol. 6, No. 5-6, 643-702 (May-June, 196
In French.

A study of the intensity, spectra and the angular distribut
of electrons following the β- and α-decays in several radioac
nuclei was made by observing the β—e coincidences with the h
of Geiger counters and scintillation detectors. The author dis
the limits of usefulness of various geometrical arrangements
measuring such coincidences and also describes the experime
for estimating the contribution from false coincidences due to
scattering and other causes. A general outline of the theory o
various secondary processes following the β-decays of nuclei
also given. The radioactive nuclei studied were P^{32}, S^{35}, Pm^{14}
RaE. From the results of his study the author concludes that
major contribution to the emission of secondary electrons is d
self-ionization process and that other secondary processes se
be unimportant for the cases studied. J.

13709 BETA EMITTERS BY HALF-LIFE AND ENERGY.
Nucleonics (USA), Vol. 19, No. 2, 70 (Feb., 1961).

Nucleonics Data Sheet No. 40. A table of beta and positr
emitters of half-lives greater than 1 min, tabulated in order o
half-life and energy. R.D

13710 A CORRIGENDUM TO THE ARTICLE "DOUBLE B
DECAY" BY H.PRIMAKOFF AND S.P.ROSEN IN
REPORTS ON PROGRESS IN PHYSICS. H.Primakoff and S.P.
Proc. Phys. Soc. (GB). Vol. 78, Pt 3, 464-5 (Sept., 1961).

See Abstr. 5020 of 1959.

13711 THE ELECTRON—NEUTRINO ANGULAR CORRE
TION IN BETA-DECAY OF HELIUM 6. B.W.Rid
Nuclear Phys. (Internat.), Vol. 25, No. 3, 483-501 (June, 1961)

The electron—neutrino angular correlation in decay of He
determined by measuring the distribution of electron energies
recoil velocities without selection of angle. The correlation p
meter α was found to be $-0.353^{+0.033}_{-0.053}$, confirming current belie
the Gamow—Teller interaction is of axial vector type. The m
mum admixture of a tensor interaction is given by $|C_T|^2/|C_A$
<0.08.

13712 THE TYPE OF INVARIANT OF THE GAMOW—TE
INTERACTION IN THE β^--DECAY OF He^6. T.Yua
J. Phys. Radium (France), Vol. 22, No. 3, 169-75 (March, 196
In French.

The energy spectrum of recoil atoms due to β^--decay of H ained using a very low pressure cloud chamber. The analysis of spectrum indicates that the type of invariant of the pure now—Teller interaction should not be T, but A.

13713 DECAY OF Ir^{195} AND Ir^{197}.

S.Homma, T.Kuroyanagi and H.Morinaga.
Phys. Soc. Japan, Vol. 16, No. 4, 841-2 (April, 1961).

The systematics of the decay of Ir^{195} and Ir^{197} were studied using lastic scintillation spectrometer. For Ir^{195}, β-decay energies of leV and ~ 0.6 MeV were found, the intensity ratio being 1 : 0.3; 1 MeV energy agrees with the expected systematics of the cess. For the 7 min decay of Ir^{197}, 2 MeV and ~ 1.5 MeV β-rays e found of equal intensity, the former agreeing with the expected aviour. Data are also given for the γ-ray spectrum of Ir^{197} luding strong γ-rays of 100, 130, 330, and 370 keV with a 2.3 hr f-life. J.W.Taylor

13714 MERCURY-206: A NEW NATURAL RADIONUCLIDE.

M.Nurmia, P.Kauranen, M.Karras, A.Siivola, A.Isola, Graeffe and A.Lyyjynen.
ture (GB), Vol. 190, 427-8 (April 29, 1961).

The natural radionuclide Hg^{206}, a daughter of Pb^{210} (α-decay) s separated from a solution containing 4 mc Pb^{210}. The β-decay ve corresponded to a half-life value of 7.5 ± 1 min for Hg^{206} and Q_β value of 1.2 ± 0.1 MeV. The half-life of the Tl^{206} daughter was min. L.Mordecai

13715 CIRCULAR POLARIZATION OF THE γ-RAYS ACCOMPANYING THE β-DECAY OF Nd^{147}.

A.Petushkov and I.V.Éstulin.
eksper. teor. Fiz. (USSR), Vol. 40, No. 1. 72-5 (Jan., 1961). Russian.

The asymmetry coefficient for $\beta-\gamma$ correlation was determined measuring the degree of circular polarization of 530 keV γ-rays companying the β-decay of Nd^{147} and found to be $A = -0.093 \pm$ 15. This value is consistent with a spin of $\frac{7}{2}$ for the state of Pm^{147} question and for a mixed E2 + M1 transition, with an amplitude tio E2/M1 equal to +1.75 ± 0.15. [English translation in: Soviet ysics—JETP (USA), Vol. 13, No. 1, 50-2 (July, 1961)].

1371[illegible] DETERMINATION OF THE MEAN BETA DISINTEGRATION ENERGY OF S^{35} BY MEANS OF AN THERMAL MICROCALORIMETRIC METHOD.

Hovi and L.Niemelä.
n. Acad. Sci. Fennicae A VI (Finland), No. 83, 10pp. (1961).

An isothermal microcalorimeter was constructed and librated for measurements of radioactive beta disintegration ergies at liquid nitrogen temperatures. The background evaporaon of the liquid nitrogen, which was caused by heat leaks into the nermost Dewar, was found to be of the order of 3.5 microwatts. e calibrated measuring accuracy of the microcalorimeter was out 1%. By using this apparatus the mean beta disintegration ergy of S^{35} was determined. From several measurements the lue 54.8 keV was found.

13717 THE RADIATION OF MESOTHORIUM I (Ra^{228}).

J.Tousset.
Phys. Radium (France), Vol. 21, No. 5, 461-2 (May, 1960). French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 60 (see Abstr. 12029 of 1961). A technique for preparation of in Ms Th 1 and Ms Th 2 sources is described. The electron ectra of these sources, obtained with a double focusing magnetic ectrometer, revealed for Ms Th 1 a strong group of conversion es at 5.5, 6.3 and 10.1 keV. These lines are attributable to a .4 keV transition, present in about 25% of the decays. The beta ectrum of Ms Th 1 is clearly visible but superimposed on the s Th 2 Auger L spectrum.

13718 DECAY OF Rh^{102} AND LEVELS IN Ru^{102}.

K.Hisatake.
Phys. Soc. Japan, Vol. 16, No. 7, 1280-91 (July, 1961).

The decay of Rh^{102} was investigated using scintillation spectroeters and a magnetic β-ray spectrometer. The negatron spectrum s an end-point energy of 1.15 MeV and the positron spectrum nsisted of two groups of end-point energies of 1.30 MeV and 82 MeV. All of β-spectra involved appeared to have approxiately "the allowed shape of the Fermi plot". 12 gamma transitions ere assigned to Ru^{102} from the internal conversion spectrum and e single and coincidence γ-ray spectra. $\gamma-\gamma$ angular correlations ere also measured. The results are consistent with the following level scheme for Ru^{102}: 0.476(2+), 1.106(2+), 1.53(3+), 1.85(?), 1.87(1+, 2+, or 3+), 2.06(?), and 2.23(3−) MeV. The transition between the first and second 2+ state was found to consist primarily of E2 transition. The branching ratio obtained for the cascade to crossover transition from the second 2+ level is (4.2 ± 0.8),

13719 INDUCED PSEUDOSCALAR INTERACTION IN $0^- \rightarrow 0^+$ BETA TRANSITIONS. D.Tadić.

Nuclear Phys. (Internat.), Vol. 26, No. 2, 338-50 (Aug., 1961).

The induced pseudoscalar term is of the form $\beta\gamma_5\{\psi_e{}^*\beta\gamma_5\psi_\nu + (\alpha Z/r_0)\psi_e{}^*\gamma_5\psi_\nu\}$. In the case of nuclei with high Z, the second part of this expression is about 20 times larger than the first, which corresponds to the phenomenologically introduced pseudoscalar coupling. The correction factors for the spectrum and longitudinal polarization in $0^- \rightarrow 0^+$ transitions and the cross terms with the induced pseudoscalar in the allowed transitions are calculated. Numerical analyses are undertaken for the $Pr^{144} \rightarrow Nd^{144}$ transition. A limitation on the ratio b_P/g_A of the induced pseudoscalar form factor b_P and the axial vector coupling constant g_A is found ($|b_P/g_A| \leq 2.7$, $f \leq 50$). All available experimental results can also be explained with $b_P \cong 0$.

13720 POSITRON RADIATION OF Tm^{166}.

J.Żylicz, Z.Preibisz, S.Chojnacki, J.Wołowski and Yu.Norseev.
Acta phys. Polon. (Poland), Vol. 20, No. 4, 321-9 (1961).

The Tm^{166} positron spectrum was examined with a long-lens beta spectrometer fitted with helical baffles for separating the electrons from the positrons. Two components were found of maximum energy 1920 ± 20 keV and 1219 ± 40 keV and of relative intensities 1 : (0.092 ± 0.018). The total number of positrons for a decay amounts to about 1%. The decay scheme of Tm^{166} and the applicability of the theory of non-axial nuclei are discussed.

13721 DECAY OF $Nd^{140} \rightarrow Pr^{140} \rightarrow Ce^{140}$.

V.Brabec, B.Kracík and M.Vobecký.
Czech. J. Phys., Vol. 10, No. 11, 855-9 (1960).

An intermediate image magnetic spectrometer was used to study the continuous β^+-spectrum of Pr^{140} and the Auger electrons of the decay chain $Nd^{140} \rightarrow Pr^{140} \rightarrow Ce^{140}$. The maximum energy of the continuous β^+-spectrum is 2318 ± 10 keV. The ratio of the intensities of the different Auger groups K—LL : K—LX : K—MX = 1 : (0.58 ± 0.05) : (0.09 ± 0.02). The ratio of the number of Auger electrons of the K-series to the electrons of the continuous spectrum e_K/β^+ is 0.292.

13722 CALCULATION OF SOME RELATIVISTIC CORRECTIONS TO THE ALLOWED AND l-FORBIDDEN BETA TRANSITIONS. G.Alaga, L.Šips and D.Tadić.

Nuclear Phys. (Internat.), Vol. 26, No. 2, 351-2 (Aug., 1961).

Erratum and addendum to a paper with the above title (Abstr. 6263 of 1958).

13723 ABSOLUTE MEASUREMENT OF Au^{198} (INTERCOMPARISON WITH HARWELL).

D.N.Bek-Uzarov, V.F.Bulović, D.R.Popović and V.V.Urošević.—
Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 19-24 (March, 1960).

Describes the techniques and methods developed for primary standardization of Au^{198}. The results obtained by solid-angle, beta—gamma coincidences and 4π beta counter methods were compared with Harwell results on the same gold foils and agreement was found within the limits of the authors' 2-6% estimated error.

13724 $\beta-\gamma$ ANGULAR CORRELATION AT RESONANCE AND TYPES OF β-INTERACTION. M.Spighel.

Ann. Phys. (France), Vol. 6, No. 5-6, 535-94 (May-June, 1961). In French.

A detailed study of the $\beta-\gamma$ angular correlation at resonance was made using a fast—slow coincidence technique. The author describes the details of the electronic circuits used in the measurement and also gives a full account of the development in the theory of β-decay. The β-decay of As^{76} and Kr^{85} was studied. On account of the low yield of $\beta-\gamma$ coincidences from Kr^{85}, no successful study of the correlation could be made. The author was able to confirm, from the study of $\beta-\gamma$ correlation in the first forbidden transition of As^{76}, that the dominant mode of interaction in this case is of V—A type. J.B.Garg

13725 $\beta^+ \to \gamma$ ANGULAR CORRELATION IN THE DECAY OF Na^{22}.

B.N.Subba Rao.

Nuovo Cimento (Italy), Vol. 20, No. 1, 178-81 (April 1, 1961).

The angular correlation between positrons and 1.28 MeV γ-rays in the decay of Na^{22} was measured. An integral correlation was first determined for all positrons greater than 120 keV in energy, and gave the result $W(\theta) = 1 - (0.015 \pm 0.003)P_2(\cos\theta)$. The differential correlation measured as a function of positron energy gave $A = -0.015 - (0.018 \pm 0.019)E$ for the coefficient of $P_2(\cos\theta)$ where E is the positron energy in MeV. It is shown that these results cannot be explained by weak magnetic effects occurring through momentum-type matrix elements $M(\alpha \times \gamma)$ which yield an A-coefficient much smaller in magnitude and opposite in sign. The large log ft value (7.39) of this apparently allowed transition is also hard to explain. R.E.Meads

13726 MEASUREMENT OF THE BETA-GAMMA CIRCULAR POLARIZATION CORRELATION IN Au^{198} AND Sb^{122}.

M.de Croës, J.P.Deutsch and P.Lipnik.

J. Phys. Radium (France), Vol. 21, No. 5, 442-5 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The preliminary results obtained are $A = 0.44 \pm 0.07$ for Au^{198} and $A = 0.27 \pm 0.07$ for Sb^{122}. The application of the information obtained in β-γ correlation measurements is discussed to first forbidden β transitions.

13727 β-γ POLARIZATION CORRELATION IN THE β DECAY OF Sc^{46}.

V.M.Lobashov, V.A.Nazarenko and L.I.Rusinov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 10-12 (Jan., 1961).
In Russian.

The correlation between the β-ray transverse polarization and γ-ray circular polarization was measured. The degree of correlation is theoretically proportional to an interference term of the type Im (VT, SA). The experimental result indicates with statistical accuracy ~30% that the term is absent. This is not inconsistent with the present theory of β-decay. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 6-7 (July, 1961)].

13728 GAMMA-VIBRATIONAL LEVELS IN ^{166}Er.

E.Bożek, H.Niewodniczański, S.Ogaza, S.Szymczyk, T.Walczak and I.A.Yutlandov.

Acta phys. Polon. (Poland), Vol. 20, No. 4, 351-6 (1961).

Directional correlation measurements for the gamma—gamma cascade 779.8—80.59 keV were performed. The values of spin I = 3 and the quantum number K = 2 for the energy level 860.2 keV were determined. The deformation of the Er^{166} nucleus in the ground and the gamma-vibrational states, as well as the rotational-vibrational interaction of energy levels in this nucleus, are discussed.

13729 GAMMA—GAMMA DIRECTIONAL CORRELATION IN Mg^{24}.

D.W.Glasgow and L.Schecter.

Phys. Rev. (USA), Vol. 123, No. 6, 2149-50 (Sept. 15, 1961).

The directional correlation between the 1.368 MeV gamma-ray and the 2.75 MeV gamma-ray of Mg^{24} was measured in an effort to strengthen the spin and parity assignment of the 4.12 MeV state. The data yield a least-squares solid-angle-corrected correlation function $W(\theta) = 1 + (0.102 \pm 0.003)\ P_2(\cos\theta) + (0.009 \pm 0.005)\ P_4(\cos\theta)$. This is consistent with the assignment (4+) for the 4.12 MeV state and analysis indicates that there can be at most 0.003% M3 radiation mixed with pure E2 radiation in the 2.75 MeV gamma-ray transition.

13730 ANGULAR CORRELATION OF THE Mo^{95} GAMMA—GAMMA CASCADES.

A.Aoki.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1086-91 (June, 1961).

The directional correlation and the polarization-direction correlation of the 838 keV-204 keV and 584 keV-204 keV gamma-gamma cascades in Mo^{95} were measured. It was found that the spin of 788 keV level is $\frac{1}{2}$, and that of the 1042 keV level is either $\frac{1}{2}$ or $\frac{3}{2}$. The branching ratio of the positron decay is also obtained as 0,4%.

13731 A STUDY OF γ-TRANSITIONS AND AUGER ELECTRONS OF Eu^{153}.

E.Monnand and A.Moussa.

Nuclear Phys. (Internat.), Vol. 25, No. 2, 292-306 (May, 1961).

A study of the low-energy conversion spectrum of $^{153}\mathrm{Sm} \xrightarrow{\beta} {}^{153}\mathrm{Eu}$ decay was carried out with an iron-free double-focusing spectrometer. The mixing ratios E2/M1 were determined by analysis of the L-conversion lines for the 70, 84 and 103 keV transitions. A 19 keV (E2) transition was revealed. The Auge and L electrons were studied and the K fluorescence yield mea

13732 TWO-PHOTON DE-EXCITATION OF THE 0$^+$ LEV IN Zr^{90}.

H.Ryde, P.Thieberger and T.Alväger.

Phys. Rev. Letters (USA), Vol. 6, No. 9, 475-8 (May 1, 1961).

De-excitation of the 1.73 MeV 0$^+$ level of Zr^{90} by simultan emission of two photons was observed. This level is fed by a β-branch (intensity 2.2×10^{-4} relative to the ground state trans in the decay of Y^{90}, which is in turn produced in the decay of Sr^{90} (ha 28 yr). The decay of the 0$^+$ 1.73 MeV level to the 0$^+$ ground state proceed by internal conversion, internal pair formation or two- emission. An experiment is described in which the probability $P_{\gamma\gamma}$ for two-photon emission is compared with that for interna conversion P_{e^-}. This gives the result $P_{\gamma\gamma}/P_{e^-} = 1.6 \times 10^{-3}$. number of two-photon emissions is then 2.7×10^{-7} per disintegration. This result is ~40 times less than the theoretical esti of Eichler and Jacob (Abstr. 1366 of 1960) in which a virtually attained state lying just higher than the 1.73 MeV state is assu to be responsible for the transition. It seems more likely that intermediate state responsible has an energy large compared 1.73 MeV. R.E.

13733 THE LEVEL SCHEME OF Eu^{153}.

L.I.Rusinov, R.L.Aptekar', V.S.Gvozdev, S.L.Sakha and Yu.L.Khazov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 79-84 (Jan., 196
In Russian.

The decay scheme of Sm^{153} ($T_{1/2}$ = 47 hr) obtained in the (n reaction was investigated. The γ-transition types were determ for transitions with energies of 69.7 keV (96.4% M1 + 3.6% E2); 84.4 keV (60% M1 + 40% E2); 103.2 keV (98.5% M1 + 1.5% E2) a 98 keV (M1). The 98 keV transition was observed for the first time. The experimental results are compared with theory. So new details of the level scheme of Eu^{153} are presented. [Englis translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 55 (July, 1961)].

13734 THE γ:β BRANCHING RATIO IN THE DECAY SCH OF K^{40}.

N.K.Saha and J.B.Gupta.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 486-91 (Sept. 26,

The γ:β branching ratio in the decay scheme of K^{40} is dete by the Uranium X$_2$ and Co^{60} comparison methods in thick samp The ratio comes out to be 0·112 ± 0·007, with the absolute rat of K^{40} β and γ-disintegrations $n_\beta = 28.8 \pm 0.9$ sec gm^{-1} and $n_\gamma = 3.22 \pm 0.15$ sec gm^{-1}, in good agreement with the results other recent determinations. The geological significance of K half life is discussed.

13735 ANGULAR CORRELATION BETWEEN NEUTRINO GAMMA-QUANTUM IN K-CAPTURE. II.

K.Nagy

Acta phys. Hungar., Vol. 12, No. 3, 193-8 (1960).

For previous work see Abstr. 5720 of 1960. Using the exa Dirac electron-function for the K-shell, the angular correlatio between neutrino and gamma-quantum following a K-capture w determined. The V—A combination for β interaction was used supposing the neutrino to be a backward longitudinally polarize particle.

13736 THE EXCITATION CURVES OF GAMMA-RAYS AN INTERNAL CONVERSION PAIRS OF F^{19}(p,α)O^{16} A Ca^{40}(p,p')Ca^{40} AND THE RELATIVE INTENSITY OF EXTERNA PAIRS OF O^{16}(d,p)O^{17}.

S.Gorodetzky, G.Sutter, F.Scheibling, P.Chevallier and R.Arm

J. Phys. Radium (France), Vol. 21, No. 5, 360 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Gren 1960 (see Abstr. 12029 of 1961). The measurement of the exci curves of internal conversion pairs and gamma-rays coming f the reaction F^{19}(p,α)O^{16} has permitted the determination of the favourable region of proton bombardment energy for the produ of monopolar pairs from the 6.06 MeV level of oxygen with mi competition from interfering non-monopolar pairs coming fro neighbouring levels.

13737 THE CONVERSION ELECTRON SPECTRA OF Lu Lu^{170}.

Z.Plajner, L.Malý and M.Vobecký.

Czech. J. Phys., Vol. 11, No. 2, 128-32 (1961).

The isotopes Lu^{169} and Lu^{170}, obtained in the fraction of ra active Lu isotopes by bombarding a Ta target with fast protons ıred on a double focusing β-ray spectrometer. The gamma tions are given together with the relative intensities of the rsion lines. The multipolarity of the transition is determined ıme gamma transitions from the internal conversion coefficients ; of the K and L shells.

3738 39 min Au^{190}, 20 min Hg^{190}, AND 10 min Hg^{189}.

G.Andersson and R.Ringh.

Fys. (Sweden), Vol. 18, Paper 27, 385-8 (1960).

[he decay of conversion electron lines from mass-separated :es was followed in a beta-spectrometer, resulting in the ving mass assignments (38.8 ± 1.8) min Au^{190}, (19.8 ± 0.6) Hg^{190}, and (9.6 ± 0.4) min Hg^{189}. The half-life of Pt^{189} was ured to be (11.1 ± 0.4) hr. Excited levels at 295 and 596 keV ^{190} are indicated from the Au^{190} decay.

3739 SOME FEATURES OF THE DECAY OF Au^{196} TO Pt^{196}.

O.Bergman.

Fys. (Sweden), Vol. 18, Paper 40, 569-73 (1960).

[he conversion and gamma-ray spectra were investigated with energy resolution. The third excited state at 1091.3 ± 0.3 keV ıssigned spin parity 1 − , and the total disintegration energy estimated to 1110 $\pm\,^{24}_{11}$ keV.

3740 LOW ENERGY GAMMA-TRANSITIONS AND AUGER ELECTRONS OF THE DISINTEGRATION $Mo^{99} \rightarrow Tc^{99}$.

vier, P.Marguin and A.Moussa.

ıys. Radium (France), Vol. 22, No. 5, 249-56 (May, 1961).

rench.

Low energy gamma-transitions from the decay $Mo^{99}_{42} \rightarrow Tc^{99}_{43}$ are ied by means of internal and external conversions, to verify e features of the disintegration scheme. The K fluorescence l and the relative intensities of K Auger subgroups are deter- ed from the spectrum of the K Auger electrons of Tc^{99}.

.3741 INTERNAL CONVERSION SPECTRUM OF Pt-192 AND Os-192.

arinkov, M.Mlađenović, M.Župančić and R.Stepić.

. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 7-13 rch, 1960).

The internal conversion spectrum of Pt^{192} and Os^{192} was meas- l and 50 conversion lines were found. The measurements were e with a 50 cm radius iron-free double-focusing spectrometer, rge permanent magnet spectrometer and an iron-clad lens.

13742 EXTERNAL CONVERSION SPECTRUM OF Pt^{192} GAMMA-RAYS FROM THE DECAY OF Ir^{192}.

lladjenović, T.Novakov and M.Župančić.

.. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 17 (March, 1960).

The relative intensities of some γ-transitions in Pt^{192} were ısured by an external conversion method in U with a 50 cm ius iron-free double-focusing β-ray spectrometer.

13743 LOW-ENERGY EXCITED LEVELS OF Tc^{99}.

J.Ravier and A.Moussa.

Phys. Radium (France), Vol. 21, No. 5, 463 (May, 1960).

French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 0 (see Abstr. 12029 of 1961). Abstract only. The internal and ernal conversions of the low-energy gamma-rays of the decay of $^{99} \rightarrow Tc^{99}$ were studied with a double focusing magnetic spectro- ter. Internal conversion coefficients of the 40 keV and 180 keV nsitions were determined by reference to the known coefficients he 140 keV transition. The K/L ratios and the conversion fficients are consistent with the assignments M1 (for 40 keV) l E2 (for 180 keV).

13744 RECENT MEASUREMENTS OF THE AUGER EFFECT IN THE K AND L SHELLS OF MEAN ELEMENTS.

Marguin.

Phys. Radium (France), Vol. 21, No. 5, 469 (May, 1960).

French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 30 (see Abstr. 12029 of 1961). Brief note, substantially as follows. e measurements were made on three nuclides Yb^{170}, Ba^{137} and ^{99}, with an iron-free double-focusing spectrometer. The usual hniques of low-energy spectrometry were employed, and pre- l post-acceleration of the electrons allowed the Auger L spectra be studied. Six Auger KLL lines were distinguished, though the theoretical prediction is nine lines for elements of intermediate Z; this may be explained by the weak intensity of some of the lines. Experimental values for the energies agree very well with theory. The ratio KLX/KLL varies with Z, contrary to the simplified calculations of Pincherle. Auger L spectra are very complex. Two values of L, corresponding to Z = 70 and Z = 56 were determined.

13745 IDENTIFICATION OF GAMMA EMITTERS FORMED BY NEUTRON ACTIVATION INCLUDING TABLES OF RADIONUCLIDES FORMED BY NEUTRON CAPTURE.

T.Westermark and B.Sjöstrand.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4, 63-77 (Dec., 1960).

Gamma-emitting nuclides formed by neutron capture (and some other neutron reactions) can be identified by measuring the half-life and gamma energy preferably against a standard which might be the nuclide suspected. The uncertainty of these two properties is used to form an uncertainty rectangle around a point on a map with the half-life on one axis and gamma energy on the other. Maps are given of neutron-formed gamma-emitting nuclides (except fission products) as listed in the Strominger—Hollander—Seaborg tables to facilitate such identification work which may be met in any radiochemical procedure, activation analysis, reactor product contamination and other work.

13746 IDENTIFICATION OF THE GAMMA-RAYS OF THE ACTINIUM FAMILY WITH A SCINTILLATION SPECTROMETER.

G.Walter and A.Coche.

J. Phys. Radium (France), Vol. 21, No. 5, 477-9 (May, 1960).

In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Using a scintillation spectrometer, a study was made of the characteristic gamma-rays of members of the actinium family. Results are presented for: Pb^{211}, Bi^{211}, Ra^{223}, Rn^{219}, Fr^{223} and Th^{227}. The experimental apparatus is outlined.

13747 γ-RAYS FROM As^{79}.

C.Ythier and R.Van Lieshout.

C.R. Acad. Sci. (France), Vol. 252, No. 17, 2543-4 (April 24, 1961).

In French.

Three different reactions were used to obtain sources of As^{79}, from which γ-rays of energy 96 ± 5 keV, 360 ± 8 keV, 430 ± 12 keV and 884 ± 20 keV were observed, with a half-life less than 15 min, in the same relative intensity. As^{79} decays via an isomeric level at 96 keV in Se^{79}. Among other levels observed from the reaction Se^{78} (d,p) Se^{79} [C. F. Corter,Jr, L.N.S. Progress Report, (May 1, 1960)] are two at 432 keV and 880 keV, and it was suggested that these may be formed by β-decay from As^{79}. V.M.Rout

13748 GAMMA-RAY SPECTRA OF SHORT HALF-LIFE EMITTERS OF MASS NUMBER CLOSE TO 80.

C.Ythier and R.Van Lieshout.

J. Phys. Radium (France), Vol. 21, No. 5, 470-2 (May, 1960).

In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1960). The gamma-ray spectra emitted by Cu^{66} (32 sec), As^{70} (52 min), Se^{81m} (61.5 min) in equilibrium with Se^{81} (18.2 min) , Se^{83} (25 min) and Br^{83} (2.3h) were measured by scintillation techniques. The sources were produced by fast neutron bombardment or deuteron bombardment in the synchrocyclotron. Various new gamma-rays were found, and coincidence relations established between some of them by the summation method, in the cavity of a 6.2 cm crystal. It is concluded that Cu^{66} certainly decays through the 2.32 MeV level of Zn^{66}, and probably excites additional higher levels, that the level scheme of Br^{81} is much more complicated than so far reported and that the 566 keV in Kr^{83} is also populated in the decay of Br^{83}. A level at 2.71 MeV is found in Br^{83} which shows properties reminiscent of collective octupole excitation.

13749 FURTHER STUDIES ON THE DECAY OF ^{132}Cs.

S.Jha, R.K.Gupta, H.G.Devare and G.C.Pramila.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1067-78 (June 16, 1961).

6.48-day Cs^{132} was made by the neutron-irradiation of natural Ba and chemical separation of Cs from Ba, and by 90 MeV proton bombardment of Cs. The following γ-rays were observed in a scintillation spectrometer: 670 keV (100), (1040 ± 20) keV (0.25 ± 0.03), (1140 ± 20) keV (0.55 ± 0.06), (1320 ± 20) keV (0.75 ± 0.08), (1700 ± 30) keV (0.01 ± 0.005), (1800 ± 30) keV (0.02 ± 0.005) and (1980 ± 30) keV (0.04 ± 0.01). By conventional coincidence and summing technique studies, the feeding of the following levels in Xe^{132} is inferred: 670 keV (93%), 1320 keV (1%), 1450 keV (0.1%), 1700 keV (0.6%), 1800 keV (1.2%) and 1980 keV (0.6%). These levels have perhaps the spin and parity 2^+, 2^+, 4^+, 2, 2, and 2 respectively. The positron branching to the 670 keV state is about 1.2%. The β^--decay to the 470 keV state of Ba^{132} is less than 3%. The decay energy of Cs^{132} is inferred to be about 2100 keV. A decay scheme is suggested.

13750 RADIATIONS FROM Eu^{145}, Eu^{146} AND Eu^{147}.

N.M.Anton'eva, A.A.Bashilov, B.S.Dzhelepov, K.G.Kaun, A.F.A.Meyer and V.B.Smirnov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 23-7 (Jan., 1961). In Russian.

The europium and gadolinium fractions separated from Ta irradiated by 680 MeV protons were investigated by means of a magnetic spectrometer and a luminescent γ-spectrometer. New γ-transitions were detected. The relative intensities of hard γ-rays from Eu^{146} were determined. More precise values were found for the energies as well as for the intensities of the conversion lines due to previously observed γ-transitions in the decay of Eu^{145} ($T_{1/2}$ = 5.6 ± 0.3 days), Eu^{146} ($T_{1/2}$ = 4.6 ± 0.3 days), and Eu^{147} ($T_{1/2}$ = 25 days). The conversion electron spectrum of the europium fraction was measured between ~20 and ~2600 keV, and the hard γ-ray spectrum was investigated up to 3500 keV. The level schemes of Eu^{145}, Eu^{146} and Eu^{147} are discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 15-18 (July, 1961)].

13751 GAMMA RAYS FROM ^{150}Eu.

G.Chilosi, P.Cuzzocrea, R.A.Ricci and G.B.Vingiani.

Nuovo Cimento (Italy), Vol. 21, No. 2, 376-8 (July 16, 1961).

The γ-rays from Eu^{150} obtained by the Eu^{151} (γ;n) reaction were studied using scintillation techniques. L.L.Green

13752 THE NEUTRON DEFICIENT IRIDIUM ISOTOPES Ir^{182}, Ir^{183} AND Ir^{184}.

R.M.Diamond, J.M.Hollander, D.J.Horen and R.A.Naumann.

Nuclear Phys. (Internat.), Vol. 25, No. 2, 248-58 (May, 1961).

The new neutron-deficient iridium isotopes Ir^{182}, Ir^{183} and Ir^{184} were produced by irradiations with the Berkeley heavy-ion linear accelerator. By means of timed chemical separations, NaI scintillation spectrometers and proportional counters, half-lives were determined as follows: Ir^{182}, 15 ± 1 min; Ir^{183}, 55 ± 7 min; Ir^{184}, 3.2 ± 0.2 hr. The gamma-ray spectra of Ir^{182} and Ir^{184} are very complex, each extending above 4 MeV. Positron branches are also seen in both isotopes. Studies of the gamma-ray spectra indicate that the energies of the first and second excited states of Os^{182} are slightly higher than the corresponding states in Os^{184}. These data suggest that there is a maximum in the moment of inertia at Os^{184}.

13753 FURTHER GAMMA-SPECTROSCOPIC INQUIRY INTO THE DECAY SCHEME OF Fe^{59}.

T.Scharbert, D.Berényi and G.Máthé.

Acta phys. Hungar., Vol. 12, No. 4, 305-10 (1960).

The gamma-rays in the decay of Fe^{59} were examined by the sum-coincidence method. The measurements definitely confirm the existence of the 1.432 MeV level and the 143 as well as the 335 keV gamma-lines. It appears on the other hand that the 1.189, 1.458 and 1.479 MeV levels known from the (p,p') scattering are not involved in the decay of Fe^{59}. In the case of the 192-1097 keV cascade, the results of the preliminary angular correlation measurements differ from those reported by Schiff and Metzger (Abstr. 6213 of 1953).

13754 ANGULAR CORRELATION [OF γ-RAYS] OF Ra^{223} (AcX). F.Bragança Gil, R.Foucher and G.Y.Petit.

J. Phys. Radium (France), Vol. 22, No. 5, 289-94 (May, 1961). In French.

The angular correlation between the γ-rays of energies 236 and 50 keV of Ra^{223} was measured using solid sources and liquid sources of various viscosities. It is shown that the 236 keV ray is of the type $E_1 + M_2$, with $(3.6 \pm 2.4) \times 10^{-4}$ M_2, and the quadrupole electric moment of the $\frac{3}{2}$+ level of the 50 keV excited state is of the order of 0.28 that of the 2+ level of the 84 keV excited state of Ra^{224}. The values of the spins of the 0, 50,286 keV excited states are analysed, and the significance of the axial quadrupolar deformation of Ra^{233} discussed.

13755 DECAY OF Rh^{102} → Ru^{102}.

F.K.McGowan and P.H.Stelson.

Phys. Rev. (USA), Vol. 123, No. 6, 2131-9 (Sept. 15, 1961).

The singles and coincident spectra of the gamma-rays from decay of Rh^{102}, which was produced by the (p, n) reaction on ruthenium containing 97.2% Ru^{102}, were measured with scintillat spectrometers. The energies (in keV) of the gamma rays are: 415 ± 4, 475 ± 5, 630 ± 6, 695 ± 7, 745 ± 8, 765 ± 8, 1050 ± 10, 1105 ± 8, 1110 ± 11, 1365 ± 10, 1565 ± 13, 1795 ± 15, 2040 ± 1 and 511 (annihilation gamma-rays). Spins of the levels in Ru^{102} which are consistent with the directional angular correlations of gamma-ray cascades are: 475(2+), 1105(2+ and 4+, doublet), 1525(3), 18400(0+),1870(3, 4, 5, or 6), 2040(2+), 2220(3), and 227 A value of E2/M1 ≥ 225 for the 630 keV transition (2 + → 2 +) w deduced from the composite correlation of the 630—475 keV casc The branching ratio of cascade to crossover transitions from th decay of the second 2+ state is 1.5 ± 0.3. The intensity of the annihilation gamma-rays decays with a half-life of 205 ± 10 day Gamma-ray spectra were measured as a function of time for 92 days and a change in the relative population of the states was observed. From this the existence of a long-lived isomeric stat in Rh^{102} is inferred.

13756 DECAYS OF PHOTOREACTION PRODUCTS OF SELENIUM. T.Kuroyanagi.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2179-87 (Dec., 1960).

The decay properties of Se^{73m}, Se^{81} and As^{79} were studied by scintillation methods. γ-ray spectra showed lines of energy 17 275, 335, 410, 480, 550, 650 and 840 keV belonging to the decay Se^{81}. The decay scheme of Se^{81} was proposed with the aid of sin and coincidence measurements of radiations. The mass differe between the ground states of Se^{81} and Br^{81} is represented by the 1.56 MeV beta ray. In As^{79}, new γ-rays of 360, 440, 725 and 89 were found. β—γ and γ—γ coincidence measurements confirme a 44-min activity in Se attributed to Se^{73m}. It is found that the β-decay energy is 1.86 MeV and that there is no appreciable γ-radiation.

13757 GAMMA-RAY SPECTRUM OF Te^{131}.

J.M.Ferguson and F.M.Tomnovec.

Nuclear Phys. (Internat.), Vol. 26, No. 3, 457-62 (Aug., 1961).

The γ-ray spectrum of 25 min Te^{131} was investigated with scintillation spectrometers. γ-rays with energies of 0.145, 0.445 0.604, 0.940, 0.985 and 1.13 MeV were found, and their relative abundances were measured. The 0.445 and 0.985 MeV gammas are in coincidence with the 0.145 MeV γ-ray. A decay scheme proposed with I^{131} levels at 0.145, 0.604, 0.940 and 1.13 MeV.

13758 HIGH-ENERGY GAMMA-RAYS AND POSITRONS FROM 5.3 hr Tl^{198}.

R.K.Gupta, J.Svedberg and G.Andersson.

Ark. Fys. (Sweden), Vol. 18, Paper 32, 443-8 (1960).

Scintillation-spectrometer studies of mass-separated Tl^{198} sources showed transitions of 2.01, 2.45 and 2.78 MeV and probably others of 1.6, 1.8 and 2.2 MeV to be present in Hg^{198}. Results of gamma—gamma coincidence measurements form the basis for a preliminary discussion of the level scheme. The en point energy of the positron spectrum was determined as 2.44 ± 0.08 MeV.

NUCLEAR REACTIONS

(Including scattering by nuclei)

13759 THE OPTICAL MODEL FOR THE ELASTIC SCATT ING OF CHARGED PARTICLES.

R.Beurtey, Guillou and J.Raynal.

J. Phys. Radium (France), Vol. 21, No. 5, 402-5 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Greno 1960 (see Abstr. 12029 of 1961). The results are presented of calculations of the angular distribution of elastically scattered charged particles, using various types of optical model potentia on the Ferranti—Mercury machine. They are compared with ex mental measurements of the scattering of 11.1 MeV protons and 44.4 MeV alpha-particles by isotopes of zinc and nickel.

3760 STRONG INTERACTIONS.
A.C.Helmholz.
. Today (USA), Vol. 14, No. 5, 28-32 (May, 1961).

Report of a conference held at Berkeley, California on
9 Dec., 1960 and sponsored by the American Physical Society.
e was an attendance of about 300 high-energy physicists. The
s discussed ranged over as wide a field as possible. The most
esting development concerned the Y* phenomenon. There was
iderable reference to the π-π interaction although no positive
rimental evidence concerning it was presented. Attention was
d to the importance of high energy inelastic processes of the
pheral or one-pion exchange type.

e to Photons

3761 NUCLEAR RESONANT SCATTERING OF PHOTONS BY THE 1.01 MeV LEVEL OF Al^{27}.
Vanhuyse and G.J.Vanpraet.
hys. Radium (France), Vol. 21, No. 5, 290-2 (May, 1960).
rench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble,
) (see Abstr. 12029 of 1961). Observed using the bremsstrahlung
trum of 2.5 MeV electrons of a linear accelerator. A self-
cation method was used to determine the mean life τ of this level
ng $\tau = (4.1^{+2.9}_{-1.6}) \times 10^{-14}$ sec.

3762 FLUORESCENCE OF THE 15.1 MeV LEVEL OF ^{12}C.
S.S.Hanna and R.E.Segel.
c. Roy. Soc. A (GB), Vol. 259, 267-74 (Dec. 6, 1960).

The resonant scattering from the 15.1 MeV level in C^{12} was
asured. The broad photon spectrum from the $Li^7(p,\gamma)Be^8$
ction was used as a source of 15.1 MeV radiation and the
onantly scattered γ-rays detected with a large NaI(Tl) crystal.
quantity $\Gamma_{\gamma_0}\sqrt{(\Gamma_{\gamma_0}/\Gamma)}$ was measured and found equal to
0 ± 6.0) eV. Combining this result with the branching ratios for
various modes of decay of the 15.1 MeV C^{12} state, the value
= (50.5 ± 7.1) eV for the ground-state transition was deduced.

13763 RESONANT SCATTERING AND ABSORPTION OF BREMSSTRAHLUNG.
ussière de Nercy and M.Langevin.
hys. Radium (France), Vol. 21, No. 5, 293-5 (May, 1960).
rench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble,
0 (see Abstr. 12029 of 1961). The nuclear resonant scattering of
ays by carbon and magnesium is studied using the bremsstrahlung
m of a betatron. The resonant scattering by the 15.1 MeV level
^{12} was first investigated. The results are in good agreement
h previous experiments. With the same method the resonant
ttering by a 10.5 MeV level of Mg^{24} can be observed. The angular
tribution of scattered photons is predominantly dipole. The peak
orption cross-section is determined and thereby the radiation
lth to the ground state and the total width of the level.

13764 ELASTIC SCATTERING OF 1.25 MeV γ-RAYS IN LEAD. G.Manuzio and S.Vitale.
ovo Cimento (Italy), Vol. 20, No. 4, 638-47 (May 16, 1961).

The degree of transverse polarization of the radiation from a
^{30} source, elastically scattered by a lead target, was measured
various angles. Experimental results are shown and a compa-
on is made between these and the theoretical predictions for
contribution of the Thomson and Rayleigh effects. Amplitudes
culated for K electrons by Brown and Mayers (Abstr. 678 of 1958)
used. For an accurate test of the theoretical situation by means
the experimental results, refined calculations of L-shell contri-
ion to Rayleigh scattering are needed.

13765 PHOTONUCLEAR CONFERENCE AT KARLSRUHE.
L.J.Laslett and D.J.Zaffarano.
ys. Today (USA), Vol. 14, No. 5, 34-8 (May, 1961).

Report of a conference held on 18-22 Aug., 1960 with an
endance of 109. The programme, as presented by rapporteurs,
vered the following topics: Recent results on photonuclear
actions; recent developments in the theory of photonuclear reac-
ns; comparison of electron-induced and gamma-induced reactions;
otonuclear reactions on deformed nuclei; experimental evidence concerning photonuclear reactions above the giant resonance; theory of photonuclear reactions above the giant resonance; new experimental techniques; semiconductor charged-particle detectors.

13766 A UNIFIED MODEL FOR NUCLEAR PHOTODISINTEGRATION PHENOMENA NEAR 20 MeV.
G.Monsonego.
J. Phys. Radium (France), Vol. 21, No. 11, 765-70 (Nov., 1960).
In French.

A unified model is formulated for the study of giant resonance, which takes into account the individual and collective character of this phenomenon. Two unitary transformations are performed on the Hamiltonian of the nucleus, introducing two new conjugate operators α and π, with a subsidiary condition on the eigenfunctions since the number of degrees of freedom are increased. In the new Hamiltonian, there are: a collective part in terms of α and π, an intrinsic part and interaction terms. This treatment based on the success of the Bohr and Mottelson phenomenological model seems to be successful: the theoretical calculations of the energy, width and cross-section of the giant resonance, agree with experimental data. The subsidiary condition plays an important role in the calculation of the width. The effect of neutron—proton exchange forces and the angular distribution of the emitted particles are also studied.

13767 COLLECTIVE MOTION IN PHOTONUCLEAR GIANT RESONANCE. M.Fabre de la Ripelle.
J. Phys. Radium (France), Vol. 21, No. 5, 302-4 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Gives a quantum mechanical justification of the Goldhaber—Teller collective model for photonuclear giant resonance using the Gammel—Thaler nucleon potential and experimental nuclear form factors. Thereby are found: (1) the energy of the giant resonance; (2) the energy of splitting for deformed nuclei; (3) the cross-section for excitation of collective motion by protons, within the Born approximation.

13768 THE DEVELOPMENT OF CASCADES INITIATED BY NUCLEAR INTERACTION. K.Pinkau.
Phil. Mag. (GB), Vol. 6, 657-67 (May, 1961).

The distribution function describing the development of electromagnetic cascades is derived under the assumption that the primary particles are γ-rays with a certain energy spectrum and angular spread. By comparing experimental results on the lateral distribution of electrons in cascades initiated by nuclear interactions with the calculations presented here one may obtain information on some characteristic features of "jets". At large distances from the cascade "core", the electron distribution is identical with that derived from ordinary cascade theory, thus indicating that the angular spread of the primary γ-rays can then be neglected. This result is of interest when measurements in large air showers are compared with theory.

13769 PHOTODISINTEGRATION OF Be^9.
J.S.Blair.
Phys. Rev. (USA), Vol. 123, No. 6, 2151-3 (Sept. 15, 1961).

The reaction $Be^9(\gamma,n)Be^8$ is discussed for those transitions in which the odd neutron goes from an initial p-state, assumed to be strongly coupled to a deformed Be^8 core, to an s-state in the continuum. The relation between this strong-coupling model and the single-nucleon calculations of Francis, Goldman, and Guth (Abstr. 673 of 1961) is given. The model is applied to experiments recently reported by Jakobson (Abstr. 10999 of 1961) and accounts for the observed increase in cross-section observed at an excitation energy of 4.6 MeV, the isotropic distribution of the neutrons associated with this rise, and the ratio of the integrated cross-section for this rise to that for the threshold peak.

13770 PHOTOPROTONS FROM CARBON.
V.J.Vanhuyse and W.C.Barber.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 233-49 (Aug., 1961).

Energy and angular distributions of protons ejected from C^{12} targets bombarded by the beam of the Stanford Mark II accelerator were measured by means of a magnetic spectrometer. The energy distributions, which are peaked at 6.0 MeV, show a structure that cannot be explained by a single resonance. Supposing that all transitions leave the residual nucleus in the ground state, the analysis of the proton distributions leads to a cross-section which has a peak value of (12.7 ± 2.5) mb and values of (41 ± 9) MeV mb and (77 ± 18) MeV mb when integrated from 0 to 24 and 40 MeV, respectively. Except for the peak value, the cross-section curve is very similar to that of the $C^{12}(\gamma, n)$ reaction. The angular distributions of the (γ, p) and $(e, e'p)$ reactions were measured for different proton energy groups at an electron energy of 40 MeV. Except for a cos θ term, the distributions are in agreement with the independent particle picture of the giant resonance, p- to d-wave transitions being the important ones. The results are also a confirmation of the theory of electron induced reactions. Yield curves as a function of electron energy were measured up to 40 MeV, for different proton energy groups and at different angles. Analysis of the yield curves leads to differential cross-sections as a function of photon energy. The main property of these cross-sections is to support to some extent the assumption of exclusively ground state transitions.

13771 PHOTOPROTONS FROM Nb^{93}.

W.C.Barber and V.J.Vanhuyse.
J. Phys. Radium (France), Vol. 21, No. 5, 299-301 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). A magnetic spectrometer was used, together with the Stanford 40 MeV linear electron accelerator, to study photoprotons from Nb^{93}. Energy and angular distributions and an excitation curve are presented and discussed.

13772 THE $(\gamma, 3n)$ REACTION IN Pr^{141}.

G.Moscati.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 321-3 (Aug., 1961).

The nuclide Pr^{141} was irradiated with a bremmstrahlung beam of 33 MeV maximum energy in the Saclay Linac. Activity due to Pr^{138} was detected and a lower limit of the integrated cross-section from threshold to 33 MeV was obtained as being 1 MeV mb. Some features of the accepted decay scheme are confirmed.

13773 AN INVESTIGATION OF THE Sn^{112} (γ, n) AND Sn^{124} (γ, n) REACTIONS.

Kuo Ch'i-Ti , B.S.Ratner and B.V.Sergeev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 85-7 (Jan., 1961).
In Russian.

The yield curves for the (γ, n) reaction in Sn^{112} and Sn^{124} were measured by means of the induced radioactivity. The peaks of the cross-section curves for the reactions Sn^{112} $(\gamma, n)Sn^{111}$ and Sn^{124} $(\gamma, n)Sn^{123}$ are located at 16.0 ± 0.5 and 15.5 ± 0.5 MeV, respectively. The corresponding total cross-sections are 1.82 ± 0.10 and 1.56 ± 0.08 MeV barn. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 60-1 (July, 1961)].

13774 HAMMER TRACKS FROM THE PHOTO DISINTEGRATION OF LIGHT EMULSION NUCLEI.

W.T.Morton and T.G.Walker.
Phil. Mag. (GB), Vol. 6, 311-12 (Feb., 1961).

Describes experiments made to identify hammer tracks due to Li^8 in C2 emulsion irradiated in a bremsstrahlung beam of maximum energy 120 MeV. From the measurements the cross-section for the photoproduction of Li^8 from C^{12}, averaged over γ-ray energies between 50 MeV and 120 MeV, was found to be $(4.9 \pm 2.0) \times 10^{-30}$ cm^2. R.H.Thomas

Due to Electrons

13775 MAGNETIC DISPERSION CORRECTIONS TO ELASTIC ELECTRON SCATTERING. A.Goldberg.

Nuovo Cimento (Italy), Vol. 20, No. 6, 1191-1204 (June 16, 1961).

The second-order dispersive corrections to the cross-section for elastic scattering of high energy electrons by He^4 are estimated The nuclear currents are the convection and spin currents of each nucleon. A closure approximation is used to evaluate the amplitude. The spin effects are calculated explicitly assuming an independent particle nuclear model for two different charge form factors. These are found to be less than 4% of the first-order cross-section. It is shown how the convection current contribution may be evaluated within the restrictions of gauge invariance. Only part of the convection terms are calculated; these are found to be much smaller than the correction due to the pure Coulomb interaction. It is concluded that the dominant contribution to the second-order correction is due to the Coulomb potential, and that this is true in general, not only for He^4. Lastly, the relevance of these corrections to experiments measuring the electron's electric and magnetic dipole moment form factors is mentioned.

13776 A SHELL MODEL CALCULATION FOR SCATTER
ELECTRONS BY Be^9. Y.R.Waghmare and S.P.Pa

Progr. theor. Phys. (Japan), Vol. 25, No. 5, 822-6 (May, 1961)

Elastic and inelastic scattering of 190 MeV electrons by g
and 2.43 MeV states of Be^9 is computed by using an intermedia
coupling shell model. The discrepancy between the calculated
the observed inelastic cross-sections reported earlier is now
removed by taking the correct spin value $J = 5/2^-$ for the 2.43
state. It is shown that a good fit to the observed data require
different radial extension parameters be chosen for the s- and
p-shell nucleons. The best values obtained are a_0 = 1.23 f for
s-shell and 2.0 f for the p-shell.

13777 SCATTERING OF HIGH-ENERGY ELECTRONS O
LIGHT NONSPHERICAL NUCLEI.

Ye.V.Inopin and B.I.Tishchenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 17-29 (1959). In Ukra

Formulae are obtained defining cross-sections for elasti
inelastic (with excitation of the rotating levels of nuclei) scatt
The calculations are made in the Born approximation, which i
sufficiently exact in the case of light nuclei. It is shown that (
the nonsphericity results in an apparent increase in the nucle
radius; (2) additional elastic scattering is caused by the pres
in the nucleus of a spin $I > \frac{1}{2}$; (3) the calculated cross-section
the excitation at the 1.37 MeV level in Mg^{24} qualitatively agree
with the experiment.

13778 MEASUREMENTS OF ELASTIC SCATTERING OF 28 MeV ELECTRONS BY HEAVY NUCLEI.

J.B.Bellicard and P.Barreau.
J. Phys. Radium (France), Vol. 21, No. 5, 296 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Gre
1960 (see Abstr. 12029 of 1961). See Abstr. 17613 of 1960.

Due to Nucleons

13779 HIGH ENERGY ELASTIC SCATTERING OF NUCL
FROM NUCLEI. ANALYSES OF EXPERIMENTA

T.Takemiya, T.Sasakawa and Y.Sakamoto.
Progr. theor. Phys. (Japan), Vol. 24, No. 6, 1307-16 (Dec., 19

The angular distributions of nucleons elastically scatter
from nuclei are analysed at energies of 95 to 340 MeV. Prev
predictions of the angular distribution (Abstr. 9848 of 1961) a
examined. All the predictions seem to be satisfied.

13780 INELASTIC SCATTERING OF NEUTRONS AND PROTONS BY NUCLEI.

O.H.Sytenko and V.F.Kharchenko.
Ukrayin.fiz. Zh. (USSR), Vol. 4, No. 5, 569-76 (1959). In Ukrai

Direct inelastic scattering of nucleons on light nuclei cau
by interaction of the incident nucleon with the external nucleo
the nucleus is considered. The interaction with the nucleus c
taken into account, using a diffraction model. The single part
wave-functions of the nucleus have been chosen according to t
shell model with an oscillator potential. As an example, the c
culations of angular distribution are carried out for the case
inelastic proton scattering on the silicon nucleus Si^{29} (p, p') Si
$(Q = -1.28$ MeV) and on the lithium nucleus Li^6 (p, p') Li^{6*}
$(Q = -2.19$ MeV).

Due to Protons

13781 PROTON SCATTERING FROM LIGHT ELEMENTS
142 MeV. - A.E.Taylor and E.Wood.

Nuclear Phys. (Internat.), Vol. 25, No. 4, 642-55 (June, 1961).

Measurements were made of the elastic scattering and to
cross-section of Be, C, N, O and Al for 142 MeV protons and
results were compared with neutron measurements at about th
same energy. A simple modification of the original optical-m
of Fernbach, Serber and Taylor (Abstr. 5006 of 1949) was foun
sufficient to explain the proton scattering results, especially i
region of the Coulomb-nuclear interference where the results
sensitive to the choice of the real part of the potential. The a

in-dependent scattering amplitudes improves the fits to the s-section data as well as giving fits to polarization measure- ts.

INELASTIC SCATTERING OF HIGH-ENERGY PROTONS AND 'ELS OF NUCLEI. See Abstr. 13639

782 ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED [6.8 MeV] PROTONS. M.M.Pucherov.
ayin. fiz. Zh. (USSR), Vol. 4, No. 3, 313-17 (1959). In Ukrainian.

The methods and results of measurements are given for Al, Co, Ni, Cu, Zn, Ag, Cd, Sn, Pb, Bi. The angular distributions the same general trend as in the higher energy region.

POLARIZATION IN PROTON—BERYLLIUM AND PROTON— TON SCATTERING AT 1.7 GeV. See Abstr. 13418

3783 ELASTIC AND INELASTIC SCATTERING OF 155 MeV PROTONS BY CARBON.
Garron, J.C.Jacmart, L.Massonnet, M.Riou and C.Ruhla.
'hys. Radium (France), Vol. 21, No. 5, 317-19 (May, 1960). rench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, (see Abstr. 12029 of 1961). The elastic and inelastic scattering erential cross-sections were determined with a scintillation scope between 5° and 60°, as a function of the scattering angle. ited levels of the carbon nucleus of 4.4, 9.6, 15 and 20 MeV were investigated.

3784 THE pp'γ REACTIONS PRODUCED BY 155 MeV PROTONS IN THE CASE OF GIANT RESONANCE.
angevin-Joliot, N.Marty and M.X.de Bouard.
'hys. Radium (France), Vol. 21, No. 5, 320-2 (May, 1960). rench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 0 (see Abstr. 12029 of 1961). In order to have more information ut the excitation of nuclear giant resonance by the inelastic ttering of protons, the γ-rays of about 20 MeV associated with excitation were examined. The ratio

$$\frac{d\sigma_{pp'\gamma}}{d\Omega} \bigg/ \frac{d\sigma_{pp'}}{d\Omega}$$

iven for scattering angles for protons of 10° and 25° for a C^{12} get, and 25° for an O^{16} target.

13785 EXCITATION OF THE GIANT DIPOLE RESONANCE BY INELASTIC PROTON SCATTERING ON CARBON.
.Sanderson.
clear Phys. (Internat.), Vol. 26, No. 3, 420-33 (Aug., 1961).

The inelastic scattering of 185 MeV protons leaving the C^{12} leus in a "giant resonance" final state is studied using the thod of distorted waves. The distortion of the scattered proton calculated in the semi-classical approximation using an optical ential with a theoretical r.m.s. radius equal to 3.04 fm. The pulse approximation is employed. Coulomb corrections are also luded. Comparison of the results with experiment is discussed some detail, with a view to the interpretation of the observed sonances.

13786 THE ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED 6.8 MeV PROTONS ON NUCLEI WITH = 26 – 30. M.M.Pucherov.
rayin. fiz. Zh. (USSR), Vol. 4, No. 3, 318-21 (1959). In Ukrainian.

The results are given of measurements on Fe, Co, Ni, Cu, Zn. e distributions for Fe and Ni at large angles show a scattering ferent from that of the other elements. Possible explanations of effect are considered.

13787 INELASTIC SCATTERING FROM HAFNIUM AND WOLFRAM ISOTOPES.
Hansen, M.C.Olesen, O.Skilbreid and B.Elbek.
clear Phys. (Internat.), Vol. 25, No. 4, 634-41 (June, 1961).

The reduced electric quadrupole transition probabilities and excitation energies of the accessible low-lying states in the able isotopes of Hf and W (except the rare isotope W^{180}) were easured by Coulomb excitation. The measurements were per- rmed on inelastically scattered protons and deuterons recorded a heavy-particle spectrograph. The results are discussed in rms of the rotational model. The measured transition probabili- s are compared with those derived from lifetime measurements.

13788 A NOTE ON EXCHANGE REACTION. T.Sasakawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1125-7 (Nov., 1960).

The Austern—Butler—McManus theory (Abstr. 1729 of 1954) is shown to be inapplicable to the exchange (p,p') reaction.

I.J.R.Aitchison

13789 NUCLEAR REARRANGEMENT AND SIMPLE NUCLEAR REACTIONS. P.Benioff.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 68-79 (July, 1961).

The effect of nuclear rearrangement on (p, pn) and (p, 2p) reaction cross-sections is considered in this work. In general it seems reasonable to require that the rearrangement effect be contained in the overlap of the wave-functions of the target and product nuclear states. It is shown that this overlap appears directly in the expression for the (p, pn) and (p, 2p) reaction cross-sections. The rearrangement effect is explicitly calculated for two independent particle models and is shown to cause a fractional change of 1/A in the reaction cross-sections.

13790 ENERGY LOSS OF PROTONS IN RARE EARTH OXIDES AND REDUCED TRANSITION PROBABILITIES FOR $2^+ \rightarrow 0^+$ TRANSITIONS IN EVEN ROTATIONAL NUCLEI.
G.Goldring and Z.Vager.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 250-8 (Aug., 1961).

Measurements of γ-ray yields from thick targets of rare-earth oxides bombarded by protons were combined with lifetime measurements to determine reduced E2 transition probabilities in $2^+ \rightarrow 0^+$ rotational transitions. The rate of energy loss of the protons in the target was determined by a measurement of the absorption of the γ-rays in the target material at different proton energies yielding the mean penetration of the protons into the target.

13791 ANGULAR DISTRIBUTION OF THE $^{11}B(p,\alpha_0)$ REACTION AT 100 TO 300 keV. R.Bouchez, H.Beaumevielle, J.Fleury, P.Perrin, R.de Swiniarski and M.Chabre.
J. Phys. Radium (France), Vol. 21, No. 12, 819-21 (Dec., 1960). In French.

The angular distribution was measured at energies of 148, 170 200 and 255 keV, and for the centre-of-mass angles from 48° to 150° (10° interval). Beyond the 2^+ 163 keV resonance and up to 180 keV, the α_0 particles are more intense forward and backward; at 148 keV, $I(\theta) \cong 1 - 0.15 \cos\theta + 0.4 \cos^2\theta$; and at 163 keV, $I(\theta) \cong 1 + 0.6 \cos^2\theta$. But this intensity decreases forward at 200 and 255 keV, prefiguring the 600 keV angular distribution for which the intensity is very low forward and backward.

13792 PROTON CAPTURE GAMMA RAYS IN THE GIANT RESONANCE REGION IN LIGHT NUCLEI.
H.E.Gove, A.E.Litherland and R.Batchelor.
Nuclear Phys. (Internat.), Vol. 26, No. 3, 480-510 (Aug., 1961).

The 90° yield of capture γ-rays leading to the ground and first excited state of C^{12} and Si^{28} was measured in the proton energy range from ≅ 3-11 MeV. This covers a range of excitation energy including the peak of the giant dipole resonance. Similar measurements were made for Mg^{24} except that, in this case the combined yield of capture γ-rays leading to the ground and first excited state was measured. Angular distributions of both γ-rays in C^{12} and Si^{28} were also measured. The cross-section at the peak of the yield for ground state γ transitions on C^{12} (22.5 MeV excitation energy) is 1.3×10^{-28} cm^2 and the integrated yield is 4.7×10^{-4} MeV.b. No fine structure is observed in the $B^{11}(p,\gamma_0)$ yield while considerable fine structure is found in the $Al^{27}(p,\gamma_0)$ and $Al^{27}(p,\gamma_1)$ yields. The yield of γ rays to the first excited state does not reach a maximum at the same energy as that for the ground state in either C^{12} or Si^{28}. There is evidence for gross double peaked structure in Mg^{24} and a suggestion of it also in Si^{28}. The angular distributions indicate that direct capture applies, if at all, only for ground state γ transitions in C^{12}. Forward asymmetry is observed in these distributions which cannot be interpreted as interference between two resonances of opposite parity separated by a spacing greater than their widths.

13793 ON HIGH ENERGY CHARGE EXCHANGE COLLISION. T.Takemiya and Y.Sakamoto.
Progr. theor. Phys (Japan), Vol. 24, No. 5, 1123-5 (Nov., 1960).

The polarization of the high-energy neutrons emitted in the quasi-elastic $C^{12}(p,n)N^{12*}$ reaction is calculated using the impulse approximation, assuming that in the final state the wave-function of the recoil proton as well as the neutron is a plane wave. The results, which agree quite well with experiment, are very sensitive to the choice of two-body phase shifts. The polarization of the total neutron yield in the p—C^{12} collision is fitted by introducing as a parameter the ratio of the spin-flip to non-spin-flip terms of the reduced nuclear matrix elements for the recoil proton.

I.J.R.Aitchison

13794 DETERMINATION OF THE CROSS-SECTIONS OF REACTIONS PROCEEDING BY DIRECT INTERACTION, INVOLVING THE RARE EARTHS.

J.Olkowsky, I.Gratot, M.Le Pape and L.Cohen.
J. Phys. Radium (France), Vol. 21, No. 5, 405-7 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The following quantities were measured: (1) the cross-section of the reaction $Ce^{142}(p,\gamma)Pr^{143}$ for $E_p = 11$ MeV, which ≅1.2 mb; (2) the excitation function of $Nd^{142}(p,d)Nd^{141}$ $E_p \leq 11$ MeV; (3) the excitation function of $Nd^{143}(\alpha,\alpha n)Nd^{142}$ for $E_\alpha \leq 44$ MeV.

13795 THE X AND γ-RAY YIELDS AND SPECTRA OF THE SUPPORTS OF TARGETS BOMBARDED BY LOW ENERGY PROTONS (0.3 TO 1 MeV).

J.Depraz, G.Legros and R.Salin.
J. Phys. Radium (France), Vol. 21, No. 5, 412-16 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The backing materials of thin targets can also emit X and γ-rays, which can mask the desired effect. The yields and spectra of X and γ-rays produced by copper, molybdenum, silver, tin, tantalum and gold are therefore determined, to assist in the choice of backing material and in the elimination of its radiation. The most satisfactory material appears to be tantalum.

13796 ANGULAR DISTRIBUTION OF THE REACTION $Li^6(p,\alpha)He^3$ FROM 100 TO 300 keV.

R.Bouchez, C.Delorme, J.Fleury, J.Krafft, P.Perrin, L.Goldman, M.Boge and B.Dudek.
J. Phys. Radium (France), Vol. 21, No. 5, 346-8 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Studied with a 300 kV electrostatic accelerator with an optic Philips tube and Sames high voltage generator, but without analyser, in the energy range $100 < T < 300$ keV. The He^3 and α particles were observed with two scintillation (CsI) spectrometers under vacuum, at laboratory angles from 30° to 150°, and the spectra were measured with an Intertechnique 200 channel selector. The experimental results indicate that the He^3 particles are preferentially emitted in the forward direction and for energies as low as 100 keV. The He^3 particle angular distribution obtained for 200, 230, 270 and 300 keV cannot be described by s and p waves alone and suggests that a direct interaction process is taking place between the proton and the deuteron group of the Li^6.

13797 ANGULAR DISTRIBUTION OF THE REACTION $Li^6(p,\alpha)He^3$ FROM 100—300 keV.

N'guyen Huu Khanh, L.Goldman and R.Bouchez.
J. Phys. Radium (France), Vol. 22, No. 5, 267-70 (May, 1961).
In French.

The angular distribution of He^3 particles from the reaction $Li^6(p,\alpha)He^3$ was measured for 144, 171, 215 and 247 keV, from 45° to 150°, using a CsI scintillation alpha-ray spectrometer and a 200 canal selector. The distribution obtained is $I(\theta) \cong 1 + A\cos\theta$ ($A \cong 0.25$), for $\theta = 60°$ to 150°, showing a strong preferential emission in the forward direction. The compound nucleus theory, with two interfering levels ($\frac{3}{2}$+ at 1.5 MeV and $\frac{5}{2}$− at 1.85 MeV), explains only 20% of the coefficient A; the greater part of the interaction seems due to a direct interaction process (pick-up) between the deuteron group of the Li^6 and the proton.

13798 ABSOLUTE MEASUREMENT OF A SET OF ENERGY CALIBRATION STANDARDS.

E.H.Beckner, R.L.Bramblett, G.C.Phillips and T.A.Eastwood.
Phys. Rev. (USA), Vol. 123, No. 6, 2100-9 (Sept. 15, 1961).

A 180° magnetic spectrometer was employed to measure the energy of several neutron thresholds and γ-ray resonances, as well as the energy of the alpha-particles emitted by Po^{210}. The primary reason for performing these experiments was to obtain a set of energy standards with consistent experimental techniques for all the measurements. The neutron thresholds studied were $Li^7(p, n)Be^7$, $B^{11}(p, n)C^{11}$, $C^{13}(p, n)N^{13}$ and $F^{19}(p, n)Ne^{19}$. The γ-ray resonances at 872 keV in $F^{19}(p, \alpha\gamma)O^{16}$ and at 992 keV in $Al^{27}(p, \gamma)Si^{28}$ were observed. The same instrument used to mak the energy measurements for these experiments was also empl to determine the energy of the alpha-particles emitted by Po^{210}

13799 MEASUREMENT OF THE LINEAR POLARIZATION GAMMA-RAYS ARISING FROM CERTAIN REACTIC

P.M.Endt, A.M.Hoogenboom and M.Suffert.
J. Phys. Radium (France), Vol. 21, No. 5, 432-4 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenc 1960 (see Abstr. 12029 of 1961). The linear polarization was measured of eight different gamma-rays emitted at resonances the reactions $Mg^{24}(p, \gamma)Al^{25}$, $Si^{30}(p, \gamma)P^{31}$, and $S^{32}(p, \gamma)Cl^{33}$. The results resolve uncertainties in either the spin or the parity of corresponding resonance level or in the E2/M1 mixing ratio.

13800 MASS SPECTROMETER DETERMINATION OF TH CROSS-SECTIONS OF HEAVY FRAGMENT PRODU BY 155 MeV PROTONS ON O^{16}.

E.Gradsztajn.
J. Phys. Radium (France), Vol. 21, No. 11, 761-4 (Nov., 1960).
In French.

The isotope dilution method applied to the determination of known cross-section of the reaction $V^{51}(n,\gamma)V^{52}$ gave satisfacto results. It was then used for studying the formation of Li^6 in O The target, bombarded with 155 MeV protons was tri-distilled Simultaneously the production cross-section of Be^7 under the s conditions was measured by counting the 480 keV γ-rays. The of these two cross-sections is in agreement with recent calcul made by Dostrovsky et al. (Abstr. 13218 of 1960).

13801 RESONANCE LEVELS IN THE REACTIONS $^{28}Si(p, \gamma)^{29}P$, $^{29}Si(p, \gamma)^{30}P$ AND $^{30}Si(p, \gamma)^{31}P$.

H.Ohmura, H.Ejiri, Y.Nakajima, K.Horie, K.Etoh, A.Ohuchi and Y.Nogami.
J. Phys. Soc. Japan, Vol. 16, No. 4, 593-7 (April, 1961).

The reactions $Si^{28}(p, \gamma)P^{29}$, $Si^{29}(p, \gamma)P^{30}$ and $Si^{30}(p, \gamma)P^{31}$ we studied in the region of proton energy from 300 to 1700 keV. T reaction $Si^{29}(p, \gamma)P^{30}$ was found to have two new resonances at p energies 1307.5 ± 3 keV and 1331.5 ±3 keV, and the reaction $Si^{30}(p, \gamma)P^{31}$ nine new resonances at proton energies 1094, 1179 1209.5, 1300, 1302.5, 1324.5, 1394.5 and 1403 keV with the erro of ±3 keV. No definite resonant level was observed in the reac $Si^{28}(p, \gamma)P^{29}$ in the range of proton energy between 570 and 1400

13802 THE SECONDARY REACTIONS OF FORMATION A ENERGY DISTRIBUTION OF ALPHA FRAGMENTS PRODUCED BY 150 MeV PROTONS ON BISMUTH.

M.Lefort, G.Simonoff and X.Tarrago.
J. Phys. Radium (France), Vol. 21, No. 5, 337 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenc 1960 (see Abstr. 12029 of 1961). Abstract only, substantially a follows. By measurement of the apparent cross-sections of fo tion of the isotopes of astatine from 206 to 211 by bombardment Bi^{209} by 150 MeV protons, the cross-section of production of al fragments responsible for these secondary reactions can be ob tained. The method used is given, taking into account the excit functions of (α, xn) reactions on Bi^{209} and the slowing down of t α-particles. Also given are some results on the emission of li and beryllium fragments by bombardment of thallium.

13803 DEUTERONS AND TRITONS EMITTED IN THE BOMBARDMENT OF CARBON NUCLEI BY 155 Me PROTONS.

P.Radvanyi and J.Génin.
J. Phys. Radium (France), Vol. 21, No. 5, 322-5 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenc 1960 (see Abstr. 12029 of 1961). The energy spectra of deuter and tritons emitted at 15°, 30°, 60° and 120° laboratory angles carbon bombarded by 155 MeV protons were measured with a s tillator telescope giving the kind and the energy of a charged p icle by simultaneous determination of its dE/dx and E. The re ing energy spectra for deuterons and tritons, between about 30 and maximum energy, are compared with the proton spectra ob tained under the same conditions. An important part of the res could be explained by pick-up reactions.

13804 (p, xn) REACTIONS INDUCED IN GOLD BY 155 Me PROTONS.

N.Poffé, G.Albouy, R.Bernas, M.Gusakow, M.Riou and J.Teilla
J. Phys. Radium (France), Vol. 21, No. 5, 343-5 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenc (see Abstr. 12029 of 1961). The (p, xn) cross-sections for ury production in gold were investigated. Masses between 197 88 were separated by magnetic deflection. Half-lives and main / energies were measured for Hg^{190}, Hg^{189}, Hg^{188} and their ıter products.

e to Neutrons

805 ANGULAR DISTRIBUTION IN THE REACTION (n,n').
M.Demeur.
ıys. Radium (France), Vol. 21, No. 5, 382-4 (May, 1960).
ench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, (see Abstr. 12029 of 1961). Nuclear stripping reactions were ed using the time dependent hamiltonian. The treatment takes account the wave functions of the bound nucleons involved in the tion mechanism.

3806 INELASTIC SCATTERING OF 14 MeV NEUTRONS BY EXCITATION OF THE 9.6 MeV LEVEL OF CARBON.
nys. Radium (France), Vol. 21, No. 5, 380-2 (May, 1960).
eyman, H.Jérémie, J.Kahane and R.Sene.
hys. Radium (France), Vol. 21, No. 5, 380-2 (May, 1960),
rench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble,) (see Abstr. 12029 of 1961). The angular distribution of 14 MeV rons inelastically scattered by excitation of the 9.6 MeV level of oon was obtained by a time-of-flight measurement. The result ined by Singletary and Wood (Abstr. 11484 of 1959) with nuclear lsions has been improved through reduction of statistical errors. angular distribution is asymmetric about a line perpendicular ıe beam, more particles being scattered forward than backward.

13807 POLARIZATION OF 0.3 TO 1.4 MeV NEUTRONS SCATTERED BY COPPER, ZINC, MOLYBDENUM AND DMIUM. D.Brown, A.T.G.Ferguson and R.E White.
lear Phys. (Internat.), Vol. 25, No. 4, 604-10 (June, 1961).

Measurements were made of the polarization of 0.5 to 1.5 MeV trons elastically scattered by Cu, Zn, Mo and Cd at 55° and Cu Mo at 90°. Marked departures are found between the results ıined and the predictions of optical-model calculations including eal spin—orbit potential.

13808 INELASTIC SCATTERING OF LOW-ENERGY NEUTRONS.
V.Naggiar.
Phys. Radium (France), Vol. 21, No. 5, 384 (May, 1960).
French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 0 (see Abstr. 12029 of 1961). Abstract only, substantially follows. The angular distribution was measured of neutrons lastically scattered by Fe^{56}, I^{127} and Bi^{209}, corresponding the first excited level of the residual nucleus. These neutrons re distinguished by their coincidence with the γ-rays of excitation of the level. Possible cascades from higher els were eliminated by setting a high enough bias on the neutron ector. It is found that at 3.2 MeV the angular distributions of neutrons inelastically scattered by iron (850 keV level) and by muth (900 keV level) are both isotropic to ±10%. The asymmetry ut the perpendicular of the angular distribution of neutrons lastically scattered by iodine (60 keV level) was measured, and s found that for incident neutrons of up to 6.5 MeV, the number ttered at 30° is the same as at 150°, to an approximation of 20%. ıally, no direct interaction was detected in the inelastic ıttering of low energy neutrons.

13809 GAMMA-RAYS FROM INELASTIC SCATTERING OF NEUTRONS BY Fe, Cu, Zn, Ge AND Se. K.Nishimura.
Phys. Soc. Japan, Vol. 16, No. 3, 355-67 (March, 1961).

γ-rays following inelastic scattering of neutrons by Fe, Cu, Ge and Se, were measured with 3.11-4.72 MeV neutrons ing a ring geometry arrangement. The excitation functions for following γ-rays were observed: 0.844, 1.23*, 1.80*, 2.11* d 2.56* MeV in Fe^{56}, 0.665, 0.965 and 1.33 MeV in Cu^{63}, 0.760 d 1.11 MeV in Cu^{65}, 0.810*, 0.995 and 1.81 MeV in Zn^{64,66,68}, 590 MeV in Ge^{74,76}, 0.830 MeV in Ge^{72}, 1.01 MeV in Ge^{76}, 0.560 MeV Se^{76} and 0.660 MeV in Se^{76,78,80}, respectively. The asterisk licates the transitions from the higher excited to the 1st excited ates. An aspect of de-excitation of higher energy levels was also discussed by analysing the ratio of probabilities of de-excitation through or not through the 1st excited state as a function of the incident neutron energy.

13810 SMALL-ANGLE ELASTIC SCATTERING OF 14 MeV NEUTRONS.
G.Deconninck, A.Martegani, J.P.Meulders and J.Stoquart.
Ann. Soc. Sci. Bruxelles I (Belgium), Vol. 75, No. 1-2, 102-5 (1961).
In French.

The cross-sections for small-angle elastic scattering for neutrons at 14 MeV were measured in four groups of elements: (Fe,Zn,Cu), (Cd,Sn), (Pb,Bi) and U^{238}. For the first group a tendency of the cross-section to decrease with the angle was observed. The results for the two middle groups are in agreement with theory. A rise in the cross-section at roughly 3° was noted in the case of U^{238}.

S.J.St-Lorant

13811 EXISTENCE OF AN INTERFERENCE EFFECT IN THE RESONANCE SCATTERING OF NEUTRONS OF ENERGIES OF 215 AND 232 eV IN PRASEODYMIUM 141. J.Julien.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3233-4 (May 24, 1961).
In French.

The neutron resonances observed in $_{59}$Pr^{141} at 215.6 and 231.7 eV were analysed taking into account the interference terms between the two resonances. From a comparison of the experimental results with this analysis, an assignment of J=3 was made for the levels of the compound nucleus at both resonances. J.B.Garg

13812 PROTON EMISSION FROM NUCLEI DUE TO NEUTRON INTERACTIONS. G.S.Mani and K.G.Nair.
Proc. Indian Acad. Sci. A, Vol. 51, No. 5, 243-57 (May, 1960).

The energy spectra of protons emitted in neutron bombardment of Al^{27} are analysed in terms of the statistical model and volume direct interaction. It is found that the diffuseness of the nuclear potential or the form of level density used does not greatly alter the shape of the energy spectra. The available experimental data agree fairly well with theory. The contribution of direct interaction is seen to be small and hence does not alter the general shape of the spectra. The direct interaction cross-section obtained from the measurements of the angular distribution in the case of iron and copper agree reasonably well with theory.

13813 ENERGY AND ANGULAR DISTRIBUTIONS OF PROTONS EMITTED FROM Al^{27} DUE TO 14.2 MeV NEUTRON INTERACTIONS. K.G.Nair, K.N.Iyengar and R.Ramanna.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 193-202 (Aug., 1961).

The Al^{27}(n,p)Mg^{27} reaction was studied for an incident neutron energy of 14.2 MeV with emulsion technique. This was a preliminary experiment in a series to be conducted to test the validity of the statistical model and the various direct-interaction models. In the present experiment the energy and angular distributions of the emitted protons indicate features of a non-compound-nucleus mechanism for the high-energy part.

13814 CROSS-SECTION MEASUREMENTS ON SOME (n,p), (n,α), (n,2n) REACTIONS.
J.Depraz, G.Legros and R.Salin.
J. Phys. Radium (France), Vol. 21, No. 5, 377-9 (May, 1960).
In French.

Low and Mean Energy Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Cross-sections of (n,p), (n,α) and (n,2n) reactions were measured for 15 MeV neutrons: Al^{27}(n,p)Mg^{24}, 59 ± 6 mb; Al^{27}(n,α)Na^{24}, 116 ± 9 mb; Fe^{56}(n,p)Mn^{56}, 128 ± 13 mb; Fe^{54}(n,2n)Fe^{53}; 7 mb; Cu^{65}(n,p)Ni^{65}; 17 ± 4 mb; Mg^{24}(n,p)Na^{24}, 203 ± 11 mb; Cu^{65}(n,2n)Cu^{64}, 869 ±104 mb.

13815 AZIMUTHAL ANGULAR DISTRIBUTION OF α-PARTICLES FROM THE B^{10}(n,α)Li^{7} REACTION WITH POLARIZED THERMAL NEUTRONS.
K.Małuszyńska, I.Natanson and Yuan-Han-Yung.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 2, 119-22 (1961).

The azimuthal distribution of the α-particles was found to be isotropic, as is to be expected theoretically. C.J.Batty

13816 DIRECT INTERACTION IN THE REACTION Be^{9}(n,2n)Be^{8}.
R.Balian and V.Gillet.
J. Phys. Radium (France), Vol. 21, No. 5, 351-2 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The results of the application of direct interaction methods to the calculation of the cross-section for the $Be^9(n,2n)Be^8$ ejection reaction are given. The neutron energy distribution shows that energies of 0.5 and 5 MeV for ejected neutrons are favoured. The total reaction cross-section, taking compound nucleus theory into account at low energies, is in good agreement with experiment.

13817 ON THE FAST EFFECT IN BERYLLIUM.

P.G.Aline, P.E.Novak and B.Wolfe.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 392-4 (April, 1960).

Calculations were made of the effect of the (n, 2n) and (n,α) reactions in a beryllium moderated reactor. The results show that the (n, 2n) effect can produce a significant improvement in the neutron economy, but uncertainties in the available experimental data preclude the determination of a meaningful quantitative result. The need for more definitive data is stressed. J.F.Hill

13818 AN ISOTOPE EFFECT IN THE COLLECTION ON CHARGED PLATES OF (n,γ) RECOIL PRODUCTS OF BROMINE.

H.J.Arnikar and A.Lal.

Indian J. Phys., Vol. 34, No. 10, 441-8 (Oct., 1960).

A study of the relative yields of Br^{80}, Br^{80m} and Br^{82} following an irradiation of C_6H_5 Br for a duration of 9 days, by an analysis of the time-decay curves, show that the apparent yield of Br^{80} on the anode plate is roughly twice that of Br^{82}. These results are discussed, vis-a-vis, standard data for the thermal neutron capture cross-sections of corresponding target atoms, Br^{79} and Br^{81} and their relative abundances. These findings, considered along with the probable counting efficiency for the resulting radioactive products and their decay characteristics, point to the existence of a small but definite net isotope effect in the overall process of (i) recoil, (ii) charge acquisition, and (iii) collection on the charged plate.

13819 EFFECTIVE NEUTRON ACTIVATION CROSS-SECTIONS OF SOME CHLORINE AND SULPHUR REACTIONS IN NRX.

R.W.Durham and F.Girardi.

Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 4-17 (1961).

Reaction rates were measured in the lattice and reflector of the NRX reactor for those neutron activation reactions of chlorine and sulphur that lead to the production of Cl^{38}, P^{32} and S^{35}. The effective cross-sections of these reactions for reactor neutrons were calculated from cobalt monitors enclosed with the irradiated samples.

13820 THE ABSORPTION CROSS SECTION OF COPPER FOR THERMAL NEUTRONS.

D.J.Donahue, R.A.Bennett and D.D.Lanning.

Nuclear Sci. Engng (USA), Vol. 7, No. 2, 184-6 (Feb., 1960).

The rate of neutron absorption in several gold and copper samples was measured in the PCTR for two different configurations of the fuel and moderator. From these rates, and the corresponding cadmium ratios, the ratio of copper to gold absorption rates for thermal neutrons, and therefore the ratio of the thermal-neutron absorption cross-section of copper to that of gold, was determined. For a value of σ_{Au} (0.0253 eV) = 98.8 ± 0.3 barns, the result σ_{Cu} (0.0253 eV) = 3.79 ± 0.04 barns is obtained.

13821 (n,α) AND (n,p) REACTIONS IN CsI CRYSTAL WITH 14 MeV NEUTRONS.

G.M.Marcazzan, E.Menichella Saetta and F.Tonolini.

Nuovo Cimento (Italy), Vol. 20, No. 5, 903-13 (June 1, 1961).

The α and proton spectra were obtained by employing a new method of mass discrimination to distinguish different particles in the CsI(Tl) crystal. The total cross-section value for (n,α) reactions was also obtained.

13822 EXPERIMENTAL CHECK OF A MONTE CARLO-CALCULATED DISTRIBUTION OF RESONANCE NEUTRON CAPTURE IN A GOLD ROD.

J.Hardy, Jr, G.G.Smith and D.Klein.

Nuclear Sci. Engng (USA), Vol. 7, No. 3, 263-7 (March, 1960).

A Monte Carlo calculation of the spatial distribution of resonance neutron capture across a 0.387 in. diameter gold rod is compared with the corresponding measured distribution, obtained by activating small gold foils stacked across a diameter of a cadmium covered gold rod. The difference between the Monte Carlo calculation and the measurement is attributed to relatively unshielded capture at energies above 250 eV, the starting energy for neutrons in the Monte Carlo calculation.

13823 MEASUREMENT OF THE ABSORBTION CROSS-SECTION OF NATURAL NEON FOR THERMAL NEUTRONS.

J.C.Carré, M.Robin and R.Vidal.

C.R. Acad. Sci. (France), Vol. 252, No. 25, 3973-5 (June 19, 196

In French.

An oscillating sample method was used to give high sensiti to absorption and low sensitivity to scattering. Hydrogen and ni gen, whose cross-sections are known, were used to obtain the constants of the apparatus. The value obtained for the absorptio cross-section of neon was 32 ± 9 mb. A.Ashr

13824 NEUTRON THRESHOLD REACTIONS: AN INTER-COMPARISON.

C.E.Mellish.

Nucleonics (USA), Vol. 19, No. 3, 114-15 (March, 1961).

By assuming a value of 60 mb for the fission spectrum cr section of the reaction $S^{32}(n,p)P^{32}$, good agreement is achieved f the published values of the cross-sections for Al^{27}, Ni^{58}, Fe^{55}, F and P^{31}. R.D.S

13825 CIRCULAR POLARIZATION OF γ-RAYS FOLLOWI THE CAPTURE OF POLARIZED NEUTRONS.

J.Vervier.

Nuclear Phys. (Internat), Vol. 26, No. 1, 10-34 (July, 1961).

The circular polarization of γ-rays following the capture of polarized neutrons was measured for some high-intensity trans tions in S^{33}, Ti^{49}, Fe^{57}, Ni^{59}, Y^{90}, Al^{28}, Cu^{64} and N^{15}. The results are consistent with spin $\frac{1}{2}$ for the 0.46 MeV level in Ni^{59}, and sp 2 for the 0.277 MeV level in Cu^{64}. The following spins are confi ed: $\frac{3}{2}$ for the 3.22 MeV level in S^{33}; $\frac{3}{2}$ and $\frac{1}{2}$ for the 1.38 and 1.72 MeV levels in Ti^{49}; 2 for the 0.777 MeV level in Y^{90}. In N^{15}, (25 ± 18)% of captures are found to occur in a state with sp $\frac{1}{2}$. In Fe^{57}, (49 ± 19) % of the intensity of the 7.64 MeV doublet γ-ray is found to belong to the ground state transition. In Al^{28}, information is obtained relating the mixture of spins in the capt state and multipole mixtures and relative intensities of the com ponents of the 7.72 MeV doublet. The results are compared wit the predictions of nuclear models and theories of thermal neutr capture.

13826 ANGULAR DISTRIBUTION OF PROTONS FROM TH REACTION $^{28}Si(n,p)^{28}Al$.

L.Colli, G.M.Marcazzan, F.Merzari, P.G.Sona and P.Tomaš.

Nuovo Cimento (Italy), Vol. 20, No. 5, 928-35 (June 1, 1961).

The energy spectrum contains four peaks, which have an anisotropic component superposed to an isotropic part, which is predominant at low proton energy. The analysis of the anisotro part shows that it can be described with sufficient approximatio by means of a direct interaction mechanism; the angular distribution shape can be correlated with the values of the shell mode orbits involved in the process of capture and emission of intera particles.

13827 TOTAL CROSS SECTIONS OF Ti, V, Y, Ta, AND W

R.E.Schmunk, P.D.Randolph and R.M.Brugger.

Nuclear Sci. Engng (USA), Vol. 7, No. 2, 193-7 (Feb., 1960).

Total neutron cross-sections have been measured by the tr mission method for metal samples of Ti, V, Y, Ta, and W in th energy range from 0.002 to 0.285 eV. The present data are in agreement, within experimental error, with the previously publ data at energies for which a comparison can be made. Absorpt cross-sections for 0.0253 eV neutrons, obtained by fitting a 1/v line to the total cross-section at cold neutron energies, give 20 ± 0.9 and 18.8 ± 0.8 barns for Ta and W, respectively.

13828 RESONANCE PARAMETERS OBSERVED IN THE ABSORPTION OF NEUTRONS BY W^{183} AND Pt^{195}.

C.Corge, V.-D.Huynh, J.Julien, S.Mirza, F.Netter and J.Simic.

J. Phys. Radium (France), Vol. 21, No. 5, 426-8 (May, 1960).

In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). A resonance analysis in terms of the one-level Breit—Wigner formula was performed to derive the level parameter values of W^{183} and Pt^{195} (5.10^{-3} μs/m resolution). The fluctuations in the neutron width Γ_n and reduced neutron width Γ_n^0 are consistent w a chi-squared distribution when $\nu = 1$, while the fluctuations in total radiative width Γ_γ for Pt^{196} + n imply a surprisingly low value of ν ($\nu = 9$) in view of the hypothesis of the independance o the partial radiative width distributions. The strength function values obtained do not disagree with the teoretical ones.

829 TOTAL NEUTRON CROSS SECTIONS OF U^{233} AND U^{235} FROM 0.02 TO 0.08 eV.
impson, M.S.Moore and F.B.Simpson.
ear Sci. Engng (USA), Vol. 7, No. 2, 187-92 (Feb., 1960).
eutron transmission measurements of U^{233} and U^{235} were ned from 0.02 to 0.08 eV. The 2200 m/sec total neutron cross- on values were calculated from a linear least-squares fit to the in this region and found to be 587 ± 6 and 690 ± 10 barns, ectively. The data were taken with the Materials Testing Reactor) fast chopper with an instrument resolution of 2 μsec/m. rimental techniques, involving the use of a 1024-channel time- ght analyser for measuring the total cross-sections at low gies, are described.

3830 CALCULATION OF THE EFFECTIVE RESONANCE INTEGRAL OF U^{238}. A.R.Vernon.
ear Sci. Engng (USA), Vol. 7, No. 3, 252-9 (March, 1960).
Methods for determining an effective resonance integral from able resonance parameter data are examined and applied to ed systems where the absorber is U^{238}. Agreement with riment is satisfactory in view of an uncertainty of about introduced by probable errors of the parameter data. empirical formula $I = a\,(S/M + b)^{1/2}$ is expected to represent eometric behaviour of I better than other two-parameter ulae when applied to a variety of fuel element compositions. uranium metal the formula is virtually indistinguishable from ormula of Gurevich and Pomeranchouk: $I = A\,(S/M)^{1/2} + B$. titative results describing the temperature and energy depend- of resonance captures are also given.

e to Mesons and Hyperons

831 THE OPTICAL MODEL IN π—NUCLEAR SCATTERING. E.Leader.
ear Phys. (Internat), Vol. 26, No. 2, 177-92 (Aug., 1961).
The optical potential for the pion—C^{12} interaction (in the 50 MeV region) is calculated in impulse approximation using ull energy dependence of the π-nucleon phase shifts. A critical ission of the comparison with experimental well depths and rential cross-sections is given. It is concluded that the model rfectly adequate for predicting gross effects but that nothing lusive can be said regarding its ability to account for the finer ls, such as the differential cross-sections.

3832 DETERMINING THE RADIUS OF MESON-NUCLEON INTERACTION. V.I.Mal'chenko.
yin. fiz. Zh. (USSR), Vol. 4, No. 4, 432-7 (1959). In Ukrainian.
The dispersion relations for the potential scattering of non- tivistic particles obtained by Khuri (Abstr. 9545 of 1957) is idered in application to potentials of the type $V(r) \sim e^{-\alpha r}$,), having a singularity at zero not exceeding 1/r. If the nates for the transmission pulse in meson—nucleon scatter- obtained by Lehmann (Abstr. 2079 of 1959) and others are ied, one may determine that the radius of meson—nucleon action $\rho_0 \leq 0.86 \times 10^{-13}$ cm.

3833 THE UNIVERSAL FERMI INTERACTION IN THE MUON CAPTURE. W.Majewski.
phys. Polon. (Poland), Vol. 19, No. 4, 525-30 (1960).
The angular asymmetry of neutrons from the capture of rized μ-mesons in complex nuclei is estimated, assuming the icability of the Fermi gas model of the nucleus. It is shown the four-fermion V—A interaction together with the conserved- ent hypothesis lead to considerable asymmetry.

3834 ^{8}Li EMISSION FROM NUCLEAR DISINTEGRATIONS PRODUCED BY 4.3 GeV NEGATIVE π-MESONS.
.) Ohta.
hys. Soc. Japan, Vol. 15, No. 12, 2187-90 (Dec., 1960).
Fifty-five Li^8 fragments from heavy element disintegrations luced by 4.3 GeV negative π-mesons were found. The frequency, energy and angular distributions of these Li^8 fragments were pared with those of the fragments produced by 5.7 GeV proton n reported by Goldsack et al. (Abstr. 4710 of 1957). No eciable difference was found between the two cases. Of light ent disintegrations, the frequency of Li^8 fragments was found about 0.006.

Due to Deuterons

13835 THE DIFFRACTION INTERACTION OF FAST DEUTERONS WITH NONSPHERICAL NUCLEI.
O.H.Sȳtenko and Yu.A.Berezhnoi.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 564-8 (1959). In Ukrainian.

The authors consider the diffraction scattering of fast deuterons on a black nonspherical nucleus having the shape of an ellipsoid of revolution. Total cross-sections are found for the possible diffraction processes: scattering, absorption and diffraction splitting of the deuteron and stripping of the neutron or proton. All total cross-sections are expressed by averaged — for all orientations of the axis of symmetry of the nucleus — areas and the perimeter of the ellipsoidal shadow of the nucleus on a plane perpendicular to the wave-vector of the incident deutron.

13836 DIFFRACTION SCATTERING OF DEUTERONS. A.G.Sȳtenko and V.K.Tartakovs'kȳi.
Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 708-23 (1959). In Ukrainian.

The authors determine the angular and energy distribution of neutrons and protons released. The energy distribution is found in both the centre of inertia system and the laboratory system. In the laboratory system, in which the nucleus was at rest before the collision, the energetic distribution is distinguished by a sharp maximum with an energy of the free particles equal to half the energy of the incident deuteron. The angular distribution of the particles released is characterized by an acute forward directivity. The curve of angular correlations between neutrons and protons is determined. The diffraction scattering of the deuteron may be detected experimentally by determining the energy spectra, as well as the angular correlation between neutrons and protons arising during the interaction of deuterons with nuclei. The distribution of nuclei during the deuteron scattering is determined. The consideration of the spin—orbit interaction of the neutron and proton with the nucleus leads to the introduction of polarization. In the low-angle region the polarizations of the released neutrons and protons are opposite in sign to the polarization arising on scattering of free neutrons and protons on nuclei.

13837 INELASTIC SCATTERING OF DEUTERONS FROM C^{12}, Mg^{24} AND Ni^{60}. Y.Ishizaki.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1056-65 (June, 1961).

The absolute differential cross-sections for the inelastic scattering of deuterons leading to the first excited state of C^{12} were measured at the bombarding deuteron energies of 14.7, 15.9 and 18.1 MeV. Similar measurements were made on Mg^{24} at deuteron energies of 15.9 and 17.5 MeV and also on Ni^{60} at 18.1 MeV. Deuterons were detected with thin CsI crystals, so that protons from (d,p) reactions did not contribute to the cross-section. The energy resolution of the detectors was less than 4%. The angular distributions show a prominent peak at small angles in all cases and the cross-sections decrease at extremely forward angles. Therefore it is not necessary to take into account an electric interaction to explain these reactions. The angular distributions are compared with the results at different deuteron energies given by other authors, and are observed to have an unusual energy dependence. The data are analysed with the nuclear interaction theory of Huby and Newns (Abstr. 4598 of 1952). When the theoretical curve is normalized to fit the measurement at the forward peak, disagreement between the theoretical curve and the experimental one occurs at the other places, which shows the need of modifing the theoretical calculations with the distorted wave approximation taking a proper optical potential into account to explain the reaction.

13838 ANTISYMMETRIC TREATMENT OF DEUTERON-STRIPPING REACTION. STRIPPING AND HEAVY-PARTICLE-STRIPPING REACTIONS. T.Honda and H.Ui.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 613-34 (April, 1961).

The deuteron stripping reaction is reformulated by using completely antisymmetric wave-functions: the amplitude of the reaction is represented as a sum of two parts, stripping and heavy-particle-stripping amplitudes. Quite analogous to the case of "ordinary" stripping, the amplitude of the heavy-particle-stripping can be represented in terms of three reduced width amplitudes of bound nucleons, e.g. in the (d,p) reaction, those of the captured neutron and proton in the residual nucleus and that of the emitted proton in the target nucleus, or alternatively, in terms of two reduced width amplitudes of the emitted proton and captured deuteron in bound states. The latter formulation is a natural generalization of that of

Owen and Madansky (Abstr. 4720 of 1957). By using the present formalism, one can calculate not only the angular distribution but also the "magnitude" of the heavy-particle-stripping cross-section. For simplicity, the Butler approximation, i.e. the cutoff Born approximation, is employed, though its generalization can be performed easily. Some qualitative discussion is given. See also following abstract.

13839 DEUTERON STRIPPING AND HEAVY-PARTICLE-STRIPPING REACTIONS. T.Honda and H.Ui.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 635-45 (April, 1961).

The formulation of the preceding abstract is applied to the analysis of experimental differential cross-sections of (d,n) reactions; especially, their dependence on the incident deuteron energy is compared with the results of previous workers, in which the ratio (λ_1/λ_2) between the matrix element of the stripping and that of the heavy-particle-stripping reactions has been taken to be an adjustable parameter. $B^{11}(d,n)C^{12}$, $Be^9(d,n)B^{10}$, and $C^{12}(d,n)N^{13}$ reactions are treated in detail. Quantitative discussions are also added concerning the dependence of the cross-sections on the reaction Q-value, on the binding energy of the emitted nucleon in the target nucleus, and on the orbital angular momentum of the captured deuteron. It is pointed out that the energy dependences of (λ_1/λ_2) obtained phenomenologically by previous workers are rather unreasonable: the experimental differential cross-sections and especially their energy dependences can hardly be explained well by merely the stripping and the heavy-particle-stripping mechanisms, provided the cutoff Born approximation be adopted in the calculation of the cross-sections. It is emphasized that calculations by means of the "distorted wave method" are definitely required.

13840 STUDIES OF STRIPPING AND PICKUP REACTIONS ON THE BASIS OF THE PAIRING PLUS QUADRUPOLE—QUADRUPOLE INTERACTION MODEL. S.Yoshida.

Phys. Rev. (USA), Vol. 123, No. 6, 2122-30 (Sept. 15, 1961).

Cross-sections for (d, p) and (d, t) reactions in units of the single-particle cross-sections (the spectroscopic factors) are calculated for spherical nuclei. It is assumed that the protons fill a closed shell and that only neutrons in an unfilled shell interact with each other through the pairing and quadrupole—quadrupole interactions. First the pairing interactions problem is solved by introducing quasi-particles according to Belyaev (Abstr. 4961 of 1959). Next the quadrupole—quadrupole interaction is diagonalized taking into account two quasi-particle states for the first excited state of even—even nuclei. Using these wave-functions the spectroscopic factors are obtained in simple form, and are evaluated numerically for the case of the Sn isotopes. Comparison is made with experiments for the transitions to the ground states of even—even and even—odd isotopes as well as to the vibrational states of even—even isotopes. Agreement in both cases is fairly good.

13841 STATISTICAL MODELS IN THE STUDY OF THE REACTION $Al^{27}(d,\alpha)Mg^{25}$.

G.Demortier, J.C.Jodogne and P.C.Macq.

Ann.Soc. Sci. Bruxelles I (Belgium), Vol. 75, No. 1-2, 94-101 (1961). In French.

The statistical theory parameters for the reaction $Al^{27}(d,\alpha)Mg^{25}$ were determined to be T = 1.7 MeV, τ = 2 MeV, t = 1.8 MeV, and a = 5.3 MeV^{-1}, in the usual notation of evaporation theory.

S.J.St-Lorant

13842 STRIPPING REACTIONS ON Be^9, Si^{28} AND Bi^{209} [USING] 13.6 MeV DEUTERONS.

M.I.Zaika and O.F.Nyemets'.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 519-21 (1959). In Ukrainian.

13843 ANGULAR DISTRIBUTIONS AND EXCITATION FUNCTIONS OF THE $Be^9(d,p)Be^{10}$ GROUND-STATE REACTION. T.Ishimatsu, N.Takano, Y.Hachiya and T.Nakashima.

J. Phys. Soc. Japan, Vol. 16, No. 3, 367-71 (March, 1961).

Angular distributions and excitation functions were studied in the energy range of deuterons from 1.7 to 3.0 MeV. Six angular distributions were measured at the deuteron energies of 1.74, 1.97, 2.24, 2.51, 2.73 and 3.03 MeV. Each angular distribution has a forward peak characteristic of the deuteron stripping process for $l_n = 1$. The yields in the backward directions, however, are predominant at the lower energies. The excitation curve taken at the laboratory angle of 30°, where the forward peak occurs in the angular distribution, shows a monotone and rather fast rise with deuteron energy. On the other hand, the excitation function of the total cross-section of this reaction shows a comparatively slow variation and has a broad peak at about 2.1 MeV of deuteron energy.

13844 EXCITATION CURVES OF CERTAIN GAMMA-RAY THE REACTION $C^{12}(d,p)C^{13}$.

S.Gorodetzky, A.Gallmann, P.Fintz and J.Samuel.

J. Phys. Radium (France), Vol. 21, No. 5, 358-9 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grend 1960 (see Abstr. 12029 of 1961). The intensities of the gamma- of de-excitation from the first three levels of C^{13} to the ground in the reaction $C^{12}(d,p)C^{13}$, were measured between E_d = 1.2 an 4.3 MeV. The excitation curves of the corresponding proton gr p_1, p_2 and p_3 were deduced. The experimental results are com with the relative intensities calculated from the penetrability fa of the protons, for different values of orbital angular momentu the reaction C^{13} + p. This makes available information about t spins and parities of levels of 11.76, 12.41, 12.61 and 12.94 Me N^{14}.

13845 THE POLARIZATION OF NEUTRONS FROM THE STRIPPING REACTION $C^{12}(d,n)N^{13}$.

A.Budzanowski, K.Grotowski, H.Niewodniczanski and J.Nurzyns

J. Phys. Radium (France), Vol. 21, No. 5, 366-8 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grend 1960 (see Abstr. 12029 of 1961). Investigated for the reaction angle θ_{lab} = 15° and deuteron energy E_d = 12.9 MeV. The polar tion of neutrons connected with the 3.56 MeV energy level in th nucleus is found to be −(0.39 ± 0.11). There are some general remarks on the preliminary values for the neutron polarization reaction angles 30°, 45° and 60°.

13846 MEASUREMENT OF NEUTRON SPECTRA FROM (REACTIONS ON LIGHT NUCLEI.

J.Juna, P.Horváth and K.Konečný.

Czech. J. Phys., Vol. 10, No. 10, 715-20 (1960).

A description is given of a fast neutron spectrometer, base the principle of measuring the time-of-flight of the neutrons. Neutron bursts are formed in a target by deflection of the ion b an accelerator by a radio-frequency voltage on the deflector. time-of-flight of neutrons is measured by a slow-fast coincide system with fast coincidence on the measuring line. The spect meter was used to measure the neutron spectra of the reaction $D(d,n)He^3$, $T(d,n)He^4$, $Li^7(d,n)Be^8$, $Li^7(d,n)2\alpha$, $Be^9(d,n)B^{10}$. Neut with energy 4.06 MeV from the reaction $Li^7(d,n)Be^8$ have not ye been reported in the literature. They correspond to the 11.7 M level in the nucleus Be^8, known from other nuclear reactions.

13847 YIELD RATIOS OF THE ISOMERIC PAIR $Ce^{137m/137}$ FORMED BY $La^{139}(d, 4n)$ Ce^{137} REACTION.

H.Vignau and S.J.Nassiff.

Nuclear Phys. (Internat.), Vol. 26, No. 1, 108-12 (July, 1961).

The variation of the yield ratio between the isomeric pair formed in the reaction $La^{139}(d, 4n)Ce^{137m/137}$ for deuteron energi up to 27 MeV was measured.

13848 THE REACTION $Mg^{25}(d, p)Mg^{26}$ IN THE ENERGY R OF DEUTERONS FROM 1.5 MeV TO 3.0 MeV. N.T

J. Phys. Soc. Japan, Vol. 16, No. 4, 598-604 (April, 1961).

Angular distributions and excitation functions of protons fr the reaction $Mg^{25}(d, p)Mg^{26}$ leading to the 1.83- and 2.97 MeV s of Mg^{26}, were investigated in the deuteron energy range from 1.55- to 3.00 MeV. The yield of protons leading to the ground were so small that this group was not measured. The results angular distributions were compared with the deuteron strippin theory, and a qualitative agreement for the second excited state group at the deuteron energies above 2.5 MeV, was obtained in forward direction (but not for the first excited state group) and in the backward direction for each group. The angular distribu of the first excited state group at the deuteron energies above 2.44 MeV, could be fitted to Bhatia's formula with two l_n-value of 0 and 2 (Abstr. 6756 of 1952). Both angular distributions inc a considerable isotropic part, and show a competition between deuteron stripping process and the compound nucleus formatio Also, the results of excitation functions for the total cross-sec were compared with the statistical theory and a fairly good agr ment was obtained with the interaction radius of (1.21 + 1.3.A $\times 10^{-13}$ cm. Furthermore, the considerably smaller yield of thi reaction seems to show that Coulomb effects play an important in this lower energy range.

349 THE ANGULAR DISTRIBUTIONS OF CHARGED PARTICLE GROUPS FROM THE DEUTERON BOM-)MENT OF NITROGEN.

Jones, D.G.Waters and V.M.Rout.
ar Phys. (Internat.), Vol. 26, No. 2, 203-8 (Aug., 1961).

'he reaction mechanism for the p_0, p_1, p_2, p_3 and α_0 groups the $N^{14}(d, p)N^{15}$ and $N^{14}(d, \alpha)C^{12}$ reactions in the region of V bombarding energy appears to be predominantly that of ound-nucleus formation with a comparatively small number of ound levels of opposite parity participating. These levels are ıfficiently numerous to be treated in a strictly statistical er despite the high excitation energy of the O^{16} compound ıus which is in the region of 22 MeV.

850 AN ATTEMPT TO CALCULATE THE REACTION $^{14}N(d,p)^{15}N^*$ BY THE BORN FIRST APPROXIMATION.

(odziejski.
phys. Polon. (Poland), Vol. 20, No. 4, 275-80 (1961).

'he stripping differential cross-sections are calculated for the when the 2S level of N^{15} is formed. Thomas' variational method plied and the angular distribution of the emerging protons is lated by the Born first approximation for four values of the of the Yukawa potential. The proton-target nucleus forces ound to be at least just as important as the neutron-target us forces. The angular distributions as obtained for the ging protons and the absolute values of the differential cross-ons are entirely different from the experimental values. The lations give some hint that in stripping reactions the capture ess takes place only on the edge of the nucleus.

851 GROSS STRUCTURE IN THE PROTON SPECTRA FROM THE $^{51}V(d,p)^{52}V$ REACTION.

Dalton, G.Parry and H.D.Scott.
. Phys. Soc. (GB), Vol. 77, Pt 5, 1098-1100 (May, 1961).

Comparison of spectra for 8.9 MeV deuterons with those of fer, Lee and Zeidman (Abstr. 13617 of 1959) for 10 MeV erons revealed some similarities and some differences. In cular the $l = 0$ group with Q-value about 1.1 MeV was not seen.

E.J.Burge

e to Alpha-particles

LPHA-PARTICLE SCATTERING: REVIEW. See Abstr. 13530

3852 ANOMALIES IN THE SCATTERING OF ALPHA PARTICLES BY CARBON. T.Mikumo.

hys. Soc. Japan, Vol. 16, No. 6, 1066-77 (June, 1961).

Angular distributions of elastic and inelastic scattering (Q = 3 MeV) of alpha particles by a carbon nucleus were measured different alpha particle energies between 27.0 and 35.5 MeV. se data are discussed together with those reported previously. ılar distributions for both elastic and inelastic alphas show arkable variation with bombarding energy and cannot be ained with simple direct interaction theories. There appear nalies in the angular distributions for E_α in the neighbourhood 0 MeV. Also in the excitation energy near 30 MeV in the pound system, some resonances were found in the elastic tation function and in the integrated cross-section for the astic scattering (Q = −4.43 MeV). Even at such high excitation rgies the effect of the compound system seems to be important.

3853 THE INELASTIC SCATTERING OF 44.4 MeV ALPHA-PARTICLES BY Ni^{58}, Ni^{60}, Ni^{64}.

eurtey, P.Catillon, R.Chaminade, M.Crut, H.Faraggi, A.Papineau, udinos and J.Thirion.
'hys. Radium (France), Vol. 21, No. 5, 399-402 (May, 1960).
'rench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble,) (see Abstr. 12029 of 1961). Using the 44.4 MeV alpha particle m of the Saclay cyclotron, the levels preferentially excited in ') experiments were studied. The energies of these states , 4, 5, 6 and 10 MeV), and the angular distribution of the astically scattered α-particles which leave the nucleus in the ited states are given. The application of the Blair inelastic ttering model allows the assignment of parity to some of the els;

13854 ANGULAR DISTRIBUTIONS OF PROTONS FROM THE ALPHA PARTICLE BOMBARDMENT OF B^{10}, N^{14}, O^{16} AND Ne^{20}. H.Yamaguchi.

J. Phys. Soc. Japan, Vol. 16, No. 4, 583-92 (April, 1961).

Angular distributions of protons from the α-particle bombardment were obtained for the following transitions, corresponding to discrete states of the residual nuclei: $B^{10}(\alpha, p)C^{13}$ ground, at bombarding energies 27.5 and 33.1 MeV; $N^{14}(\alpha, p)O^{17}$ ground, first, second, third at bombarding energies 26.8, 28.1 and 33.3 MeV; $O^{16}(\alpha, p)F^{19}$ ground to second (unresolved), third to fifth (unresolved), sixth at bombarding energies 26.7 and 33.1 MeV; and $Ne^{20}(\alpha, p)Na^{23}$ ground and first (unresolved), second to sixth (unresolved) at bombarding energy 26.9 MeV. These angular distributions show the so-called diffraction patterns and some of them are interpreted with the aid of predictions of the direct interaction theory. However, some deviations from the predictions of the direct interaction theory exist and suggest the effect of other nuclear reaction processes.

13855 ANGULAR DISTRIBUTION OF (α,p) REACTIONS IN SOME LIGHT NUCLEI.

M.Kondo, T.Yamazaki and S.Yamabe.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1091-8 (June, 1961).

The angular distributions of the proton groups corresponding to the lower states of the residual nuclei from the reactions $C^{12}(\alpha,p)N^{15}$ gnd; $F^{19}(\alpha,p)Ne^{22}$gnd, $_{1.28}$ MeV; $Al^{27}(\alpha,p)Si^{30}$gnd, $_{2.24}$ MeV; and $Si^{28}(\alpha,p)P^{31}$gnd, $_{1.27,\ 2.23,\ 3.13 \sim 3\ 51}$ MeV were measured using 22.5 ± 0.2 MeV alpha particles. The angular distributions of the $C^{12}(\alpha,p)N^{15}$gnd reaction are energy dependent. At 20.6 MeV steep rise in the forward angles is observed, but at 22.2 MeV the steep rise in the backward angles appears instead of the forward rise. The angular distributions of the $F^{19}(\alpha,p)Ne^{22}$ reaction are both peaked in the backward angles. The angular distributions of the $Al^{27}(\alpha,p)Si^{30}$ and the $Si^{28}(\alpha,p)P^{31}$ reactions show the diffraction-like patterns and they are interpreted with Butler's direct interaction theory (Abstr. 5032 of 1959).

13856 DIFFERENTIAL CROSS-SECTION OF THE REACTION $C^{13}(He^3,\alpha)C^{12}$ AT 1.8 MeV.

R.Barjon, M.Lambert and J.Schmouker.
J. Phys. Radium (France), Vol. 21, No. 5, 356-7 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The differential cross-section for the reaction $C^{13}(He^3,\alpha)C^{12}$ for incident He^3 of 1.8 MeV energy and the excitation curve at a c.m. angle of 166° 15' were measured. To explain the results, a mixture of "pick-up" and "alpha-particle stripping" processes is required.

13857 THE THRESHOLD OF THE $^{13}C(^3He,n)^{14}O$ REACTION. J.H.Towle and B.E.F.Macefield.

Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1217-19 (June, 1961).

The work was undertaken in order to resolve a discrepancy between measurements reported previously by Bromley et al. (Abstr. 3631 of 1957) and Butler (1956), and Bondelid et al. (1958). The measured value of 1437.0 ± 0.9 keV is in agreement with the results of Butler and Bondelid et al. and has been confirmed by a further result of Bardin et al. Considerable details of the experimental arrangement are given.

B.Brown

13858 REACTIONS WITH EMISSION OF HELIUM 3 CAUSED BY 43 MeV α-PARTICLES BOMBARDING ISOTOPES OF IRON, NICKEL AND COPPER. J.Saudinos, R.Beurtey, P.Catillon, R.Chaminade, M.Crut, H.Faraggi, A.Papineau and J.Thirion.

C.R. Acad. Sci. (France), Vol. 252, No. 24, 3776-8 (June 12, 1961).
In French.

A certain number of reactions of the type $X^A(\alpha,He^3)\ X^{A+1}$ were studied. The excitation of certain levels or groups of levels in the residual nuclei is established and experimental results are shown in graphical form for the bombardment of Fe^{56}, Ni^{60}, Ni^{64}, and Cu^{65}. The angular distributions at He^3 in the case of $Fe^{56}(\alpha,He^3)Fe^{57}$ show a strong predominance to the forward direction.

B.Brown

13859 EXCITATION FUNCTION FOR THE REACTION $O^{16}(\alpha,pn)F^{18}$. M.Furukawa and S.Tanaka.

J. Phys. Soc. Japan, Vol. 16, No. 1, 129 (Jan., 1961).

The energy dependence of cross-sections for the reaction $O^{16}(\alpha,pn)F^{18}$ was determined for α-particle energies up to 40 MeV. Details of experimental technique and apparatus are given. It was found that F^{18} was produced below the threshold energy of the (α,pn) reaction and it is thought deuteron emission is very important in this case.

B.Brown

DETERMINATION OF THE CROSS-SECTIONS OF REACTIONS PROCEEDING BY DIRECT INTERACTION, INVOLVING THE RARE EARTHS. See Abstr. 13794 .

Due to other Particles and Nuclei

13860 NUCLEAR REACTIONS INDUCED BY HEAVY IONS: POINTS OF INTEREST AND VARIOUS APPLICATIONS. M.Lefort.
J. Phys. Radium (France), Vol. 21, No. 8-9, 665-73 (Aug.-Sept., 1960). In French.

A survey of nuclear phenomena induced by multicharged heavy ions. Several features are discussed: reactions involving a fusion nucleus; "buckshot" reactions in which heavy ions are broken into several fragments in the vicinity of target nuclides; disintegration stars and transfer reactions. The usefulness of heavy ion reactions for measuring fission width and Γ_n/Γ_f ratios is emphasized. Also the production of neutron deficient nuclides and of transuranic elements is discussed.

13861 EXPERIMENTS WITH 2 MeV LITHIUM IONS. S.M.Shafroth.
J. Phys. Radium (France), Vol. 21, No. 5, 353-4 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The 2 MeV Van de Graaff at Saclay has been adapted for lithium ion acceleration. The reactions $Li^6 + C^{12}$ and $Li^7 + C^{12}$ were studied using nuclear plates in a scattering chamber. Measurements of the differential cross-sections and angular distributions of the various products are given.

13862 NUCLEAR REACTIONS PRODUCED BY LITHIUM IONS. L.Marquez.
J. Phys. Radium (France), Vol. 21, No. 5, 355-6 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Studies the γ-rays produced by the irradiation of Be^9 by 2 MeV Li^6 γ-rays of 475, 720 and 1020 keV were found, corresponding respectively to the first excited state of Li^7 and to the first and second excited states of B^{10}.

13863 THE REACTIONS OF Li^6 IONS ON BERYLLIUM. C.Lemeille, L.Marquez, N.Saunier and M.Coste.
J. Phys. Radium (France), Vol. 22, No. 6, 349-52 (June, 1961). In French.

Studies the nuclear reactions produced by Li^6 ions of energies up to 2 MeV on Be. Results obtained with scintillation counters, nuclear plates and junction counters are presented. Possible reaction mechanisms are discussed.

13864 STRIPPING ANALYSIS OF THE $Be^9(Li^6,\alpha)B^{11}$ REACTION. J.J.Leigh.
Phys. Rev. (USA), Vol. 123, No. 6, 2145-8 (Sept. 15, 1961).

An analysis of the angular distributions of α-particles from the $Be^9(Li^6,\alpha)B^{11}$ reactions was carried out using a simple "lump" stripping model. Both the normal stripping mode and that exchange mode commonly called "heavy-particle stripping" were incorporated in the analysis. The model assumes that the Li^6 and the Be^9 nuclei may be represented by the two-cluster configurations "alpha-particle plus deuteron" and "alpha-particle plus He^5" respectively. The angular distribution calculated for the first excited-state reaction provides a satisfactory fit to previously published experimental results at a laboratory bombarding energy of 3.25 MeV. The theoretical angular distribution for the ground-state reaction is less successful but does show the principle features of the experimentally observed angular distribution.

13865 THE TWO-STAGE NUCLEAR REACTION $N^{14}(t,n)O^{16*}(p)N^{15}$.
N.Jarmie, M.G.Silbert and D.B.Smith.
Nuclear Phys. (Internat.), Vol. 25, No. 3, 443-6 (June, 1961).

A remarkably clear examples of a two-stage nuclear reaction was observed. Broad, steep-sided proton groups, observed during the bombardment of nitrogen by tritons, were ascribed to the process $N^{14}(t,n)O^{16*}(p)N^{15}$. It is notable that this reaction appears to proceed by way of particular sharp states in O^{16} at an excitation of about 15 MeV.

13866 VERY HIGH ENERGY NUCLEAR REACTIONS AND ALPHA-PARTICLE MODEL. H.Hasegawa and K.I
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 300-1 (Feb., 1961)

The probabilities that one or more α-particles are emitte the collision of heavy primary cosmic-ray particles with emul nuclei are estimated, assuming the incident nucleus has an α-particle structure. There is reasonable agreement with expe ment. R.J.N.Ph

Nuclear Fission

13867 THE THEORY OF NUCLEAR FISSION. IV. THE INFLUENCE OF THE MAGIC NUMBERS ON NUCL FISSION. W.Brunner and H.Paul.
Ann. Phys. (Germany), Vol. 8, No. 34, 146-57 (1961). In Germa

For Pt II-III, see Abstr. 7409 of 1961. The use of "the ma effect" is illustrated by a discussion of the spontaneous fission Cf^{252}, and also the symmetric fission of Bi^{209} by deuterons is ex ed. In addition a qualitative explanation is given for the well k lessening of the asymmetry of fission when fission is by high e neutrons. J.

13868 MEASUREMENT AND ANALYSIS OF THE FISSION CROSS-SECTION OF U^{238}.
A.Michaudon, R.Bergère, A.Coin and R.Joly.
J. Phys. Radium (France), Vol. 21, No. 5, 429-32 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenc 1960 (see Abstr. 12029 of 1961). Remeasured by the time-of-fl technique with the Saclay 28 MeV linear electron accelerator a pulsed neutron source. The resolution was 0.01 μs/m in the w energy range (7 to 95 eV). Fission was detected with an ioniza chamber and the neutron spectrum measured with an assembly of BF_3 counters. Improvements in resolution, statistical accur and background are described. Area analysis of the resonance gives a set of values of $\sigma_0\Gamma_f$. Shape analysis of the low energy nances was undertaken; at 8.78 eV a large broadening was obse and this is discussed.

THE CRYSTAL SPECTROMETER OF THE EL3 PILE AND TERNARY FISSION OF U^{235}. See Abstr. 13906

13869 MEAN NUCLEUS OF PROMPT NEUTRONS EMITT IN THE FISSION OF ${}^{238}U$, ${}^{239}Pu$, ${}^{232}Th$. J.Leroy.
J. Phys. Radium (France), Vol. 21, No. 8-9, 617-28 (Aug.-Sept. 1960). In French.

Summarizes a set of measurements carried out at Saclay fissions induced by 14.2 MeV neutrons, relative to the U^{235} ther fission $\bar{\nu}$ value:

$$ {}^{236}_{92}\bar{\nu}\ (0.025\ \mathrm{eV}) = 2.47 \pm 0.03. $$

The following values were obtained:

$$ {}^{239}_{92}\bar{\nu}\ (14.2\ \mathrm{MeV}) = 4.55 \pm 0.15 $$

$$ {}^{240}_{94}\bar{\nu}\ (14.2\ \mathrm{MeV}) = 4.75 \pm 0.4 $$

$$ {}^{233}_{90}\bar{\nu}\ (14.2\ \mathrm{MeV}) = 4.64 \pm 0.2. $$

Another group of measurements gave the average number of pr neutrons ${}^{239}_{92}\bar{\nu}(E)$ emitted per U^{238} fission induced by a fission n spectrum, and ${}^{238}_{92}\bar{\nu}$ (spont.) emitted per U^{238} spontaneous fission

[illegible] $$ {}_{92}\bar{\nu}\ (E) = 2.89 \pm 0.07 \quad E = 3.1\ \mathrm{MeV} $$

$$ {}^{238}_{92}\bar{\nu}\ (\mathrm{spont.}) = 2.10 \pm 0.08. $$

13870 FISSION OF URANIUM-238 WITH CARBON IONS. T.Sikkeland, A.E.Larsh and G.E.Gordon.
Phys. Rev. (USA), Vol. 123, No. 6, 2112-22 (Sept. 15, 1961).

Angular distributions and kinetic-energy spectra of fragme and cross-sections for fission of U^{238} with 63 to 124 MeV C^{12} io were measured with the use of a silicon p—n junction detector. distributions were analysed in terms of the formation of a com nucleus and subsequent decay by evaporation of neutrons in competition with fission. The percent fission from each isotop the evaporation chain was calculated and the over-all angular distribution estimated with the use of the theoretical curves of Halpern and Strutinski (1958). At the highest bombarding ener the observed angular distributions were found to be more near isotropic than predicted. The mean linear momentum of the fissioning nucleus appears to be less than that of the heavy ion.

ble explanation for these discrepancies is that before the fission . there is competition from reactions in which particles are ed in the forward direction. The contribution from this kind action is estimated to be of the order of 30% at 95 and 124 MeV. the entire range of bombarding energies, the most probable kinetic energy release is 186 ± 6 MeV. By correspondence suggests the fissioning nuclei are californium isotopes. The on cross-section increases from a value of 40 mb at 63 MeV to at 124 MeV. The experimental fission cross-sections agree with the cross-sections for compound-nucleus formation lated by use of a square-well nuclear potential with a radius meter $r_0 = 1.5 \times 10^{-13}$ cm.

871 FISSION-SPALLATION COMPETITION IN THORIUM TARGETS BOMBARDED BY 155 MeV PROTONS.
efort, G.Simonoff and X.Tarrago.
ys. Radium (France), Vol. 21, No. 5, 338-42 (May, 1960).
ench.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, (see Abstr. 12029 of 1961). Cross-section measurements were on the formation of several isotopes of thorium and actinium, mbarding Th^{232} with 155 MeV protons. These cross-sections also calculated for spallation processes in three steps: t interaction, neutron evaporation, and fission-evaporation etition in excited nuclides. $\Gamma n/\Gamma f$ values are examined and lations compared with experiments.

3872 PROMPT FISSION NEUTRON SPECTRUM OF Pu^{241}
A.B.Smith, R.K.Sjoblom and J.H.Roberts.
. Rev. (USA), Vol. 123, No. 6, 2140-2 (Sept. 15, 1961).

The energy distribution of prompt neutrons resulting from the mal-neutron-induced fission of Pu^{241} was measured. Fast time-ight techniques were employed in the neutron energy range 0.3 0 MeV. Proton recoils in emulsions were utilized for the measnent of neutron energies from 1.6 to 7.0 MeV. The experiment-determined Pu^{241} fission neutron spectrum is well represented e Maxwellian distribution, $N(E) \propto E^{1/2}e^{-E/T}$, where E is the ron energy in MeV, N(E) the number of neutrons per unit energy val, and T = 1.335 ± 0.034 MeV. The measured average Pu^{241} on neutron energy is 2.002 ± 0.051 MeV.

ermonuclear Reactions

3873 ELEMENTARY PROCESSES RELATED TO THE CATALYTIC ACTION OF μ^- FOR THE p–d FUSION CTION. Y.Mizuno.
hys. Soc. Japan, Vol. 16, No. 6, 1043-55 (June, 1961).

The following four problems are studied theoretically: (a) the tion of three-body problems associated with one meson and two ogen nuclei; (b) the number and type of bound states belonging esonic hydrogen molecular ions; (c) the determination of the inant mechanism of molecular ion formation; (d) the relation of process, $(p\mu d)_s \to He^3 + \gamma$, to the so-called mirror reaction, $d \to H^3 + \gamma$. The theory is shown to be in good quantitative agreet with the experiment for nuclear as well as molecular proses.

NUCLEAR POWER STUDIES

3874 BASIC INFORMATION ON NUCLEAR ENERGY.
H.Grümm.
ktrotech. u. Maschinenbau (EuM) (Austria), Vol. 77, No. 19, -65 (Oct., 1960). In German.

A review article (intended principally for engineers) dealing problems of nuclear energy. Topics discussed include nentary nuclear physics, physics of nuclear reactors, extraction eat from nuclear reactors, main types of nuclear reactors, iation protection, and the present status of nuclear fusion earch. The article ends with a comparison of research work in tria and the rest of Europe. R.H.Thomas

3875 INVESTIGATION OF THE SR-1 HETEROGENEOUS SUBCRITICAL ASSEMBLY.
ál, F.Szabó, Z.Gyimesi, L.Bata and L.Turi.
phys. Hungar., Vol. 12, No. 3, 205-19 (1960). In Russian.

The results of experiments carried out on the subcritical assembly consisting of cylindrical fuel elements (enriched in U^{235} to 10%) and distilled water are reported. The critical mass and the effect of local distortions in the core on criticality are determined. The distributions of thermal as well as resonance neutrons in the core, in the reflector and between two adjacent fuel elements are measured. The asymptotical distribution of the thermal neutrons in the reflector is studied.

13876 THE LINEAR EXTRAPOLATION LENGTH ON THE SURFACE OF AN INFINITE PLATE [IN A REACTOR CELL]. M.Angelopoulos.
Atomkernenergie (Germany), Vol. 5, No. 6, 217-22 (June, 1960).
In German.

The use of elementary diffusion theory for the calculation of the flux distribution of thermal neutrons in a reactor cell meets with difficulty, in that it leads to great inaccuracies in the neighbourhood of boundary surfaces and in the inside of thin absorbing media. The present paper deals with an infinite plate surrounded by a moderator, using the multiple-collision method for the plate and a P_3-approximation for the moderator. The formulation of the problem enables the extension of the method to a higher P_{2n-1}-approximation for the moderator. The results obtained are compared numerically with those given by the application of a P_{2n-1}-approximation (n = 1, 2) throughout the geometry. The calculation of the flux depression in the plate is also given.

13877 NEUTRON FIRST COLLISION PROBABILITIES IN REACTOR PHYSICS. R.Bonalumi.
Energia nucleare (Italy), Vol. 8, No. 5 (73), 326-37 (May, 1961).

The different types of collision probabilities are given which may be involved in a nuclear reactor with concentric annuli lattice cells. Simple approximate methods are presented for calculating these quantities. The second part of the paper deals with various typical applications of the calculations to some parameters of a reactor, e.g. diffusion coefficients, the effective surface in calculations of resonance integrals, rod blackness, disadvantage factors and thermal utilization factors. A.J.Salmon

13878 A LIQUID LOOP AS A RADIATION SOURCE, WITH PARTICULAR REFERENCE TO RADIATION CHEMISTRY. II. Iu.S.Riabukhin and A.Kh.Breger.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 72-81 (July, 1960).

The solution for a loop containing one radioisotope given in Pt I [Reactor Technology (Journal of Nuclear Energy, Part B) (GB), Vol. 1, 109 (1959)] is extended to the general case of several radioisotopes with daughter products. The absolute maximum power output of the loop and the consumption of neutrons per unit of power are discussed for several of the elements which can be used in the loop. Indium and its alloys are the most promising materials. Special attention is given to a loop containing fissile isotopes (the "uranium loop"), and it is shown that, under similar conditions the specific output of such a loop is considerably lower than that of a loop containing indium or its alloys. As a special case of the uranium loop, a loop is considered in which incompletely spent fuel elements are repeatedly circulated between the reactor and the irradiation unit. It is shown that the power is in this case 2-4 times higher than that obtained by using completely spent fuel elements once only.

13879 COLLISION PROBABILITIES AND RESONANCE INTEGRALS FOR LATTICES. W.Rothenstein.
Nuclear Sci. Engng (USA), Vol. 7, No. 2, 162-71 (Feb., 1960).

A formula for the escape probabilities of neutrons from the fuel lumps to the moderator and vice versa in a lattice is derived and the validity of simple approximations discussed. These formulae are applied to solve the coupled integral equations for the collision densities in a lattice. First-order corrections to the resonance integral are obtained both for the Narrow Resonance and the Narrow Resonance Infinite Absorber approximations. Numerical results are given for water lattices containing hexagonal arrays of U^{238} rods, of 0.25 and 0.60 in. diameter, at different water-to-metal volume ratios.

13880 PREDICTING BURNUP OF STAINLESS-UO_2 CERMET FUELS. D.L.Keller.
Nucleonics (USA), Vol. 19, No. 6, 45-8 (June, 1961).

Irradiation experiments performed on cermet fuels of various compositions are summarized and it is shown that a safe burnup limit can be predicted for each composition as a function of surface temperature. Theories of the growth of the UO_2 particles, and the effects of fission product escape and damage to the matrix, are briefly reviewed and it is suggested that performance of these reactor fuels could be improved by avoiding "stringering" (for example by a lower reduction during rolling) and by using spherical UO_2 particles.

R.D.Smith

13881

INTEGRAL TRANSPORT THEORY OF THERMAL UTILIZATION FACTOR IN INFINITE SLAB GEOMETRY.

M.H.Theys.

Nuclear Sci. Engng (USA), Vol. 7, No. 1, 58-63 (Jan., 1960).

Using transport theory in the cylindrical fuel region of a heterogeneous reactor, Amouyal and Benoist (Abstr. 7659 of 1960) have proposed new formulae to compute the disadvantage factors used in the determination of the thermal utilization factor. The same method when applied to an infinite slab geometry gives simple expressions for the fuel and moderator disadvantage factors.

13882

SPACE-DEPENDENT PROMPT KINETICS OF A SUBCRITICAL REACTOR. J.Agresta and L.B.Borst.

Nuclear Sci. Engng (USA), Vol. 7, No. 1, 64-8 (Jan., 1960).

A method of calculating space-dependent reactor kinetics by direct numerical integration of the time-dependent multigroup equations is described. In particular, this method is applied to study the buildup and decay of neutron flux in a subcritical reactor with a step-function point external source.

13883

ACCURACY OF THE S_n CODE IN CELL CALCULATIONS. A.V.Campise.

Nuclear Sci. Engng (USA), Vol. 7, No. 2, 104-10 (Feb., 1960).

The neutron balance of a reactor system is probably the most important single quantity to be obtained from an analysis of static core physics. In a heterogeneous reactor configuration, an accurate knowledge of the different reaction rates must be obtained by first studying the unit cell. The results for the unit cell are used in the homogenization of the reactor lattice so that a multi-group, multi-region reactor programme may be used to investigate the reaction rates of the reactor system. A study was made of the ability of the S_n form of the neutron Transport Equation to describe accurately the thermal neutron flux distribution in a unit cell. The uncertainties introduced into the problem by spectrum hardening in heterogeneous cells were minimized by confining most of the comparison of theory with experiment to natural uranium rods in diphenyl and D_2O. A slightly enriched uranium slab in a water lattice was used for comparisons of published results. Results are evaluated on the basis of the S_n method's ability adequately to calculate the spatial variation of the thermal flux distribution when compared with experiment. Excellent agreement was obtained for the S_n calculations.

13884

THE USE OF THE GENERATION TIME IN REACTOR KINETICS. J.Lewins.

Nuclear Sci. Engng (USA), Vol. 7, No. 2, 122-6 (Feb., 1960).

The operational and conceptual significance of the reactor kinetics parameters is considered, with especial reference to the generation time, the reciprocal production probability. The kinetics equations are given in a form parametric in the generation time, a form which is usually more accurate and always simpler to solve than the corresponding form in the lifetime, the reciprocal destruction probability. Typical solutions are given for several simple and more sophisticated problems employing a further useful set of nondimensional parameters.

13885

CONVERGENCE OF THE S_n METHOD FOR THERMAL SYSTEMS. E.Blue and H.P.Flatt.

Nuclear Sci. Engng (USA), Vol. 7, No. 2, 127-32 (Feb., 1960).

It has been observed in the past that the computer time required for the numerical solution of the transport equation has been almost prohibitive for many problems of interest. Results of a study designed to improve the convergence rate of the angular segmentation or S_n method are presented. Examples showing the effect of several different modifications of the standard S_n method are given. It is recommended that the incorporation of the modification discussed will significantly improve the convergence of the S_n method and permit an efficient solution of many problems related to thermal assemblies.

13886

MANY-FOLD MOMENT METHOD. D.Schiff and S.Ziering.

Nuclear Sci. Engng (USA), Vol. 7, No. 2, 172-83 (Feb., 1960).

An extension of Yvon's method to two-dimensional transport theory is given. The detailed formalism in P_1 approximation is presented. Some pilot calculations on two-dimensional critical sizes performed on an IBM 704 are presented both for bare and reflected reactors. A brief outline of extending this method to both three-dimensional and multigroup problems is given in an appendix.

13887

METHODS AND CROSS SECTIONS FOR CALCULAT THE FAST EFFECT. M.R.Fleishman and H.Sooda

Nuclear Sci. Engng (USA), Vol. 7, No. 3, 217-27 (March, 1960).

The Spinrad three-group theory of the fast effect is formul Recipes are presented for determining the necessary cross-sec directly from fundamental data and three-group cross-sections various materials are tabulated. A comparison is made betwee three-group theory and one-group theory with respect to the ca tion of R, the ratio of fast-to-thermal fissions, and it is found t the three-group theory appears to give better agreement with e ments. The three-group values of $\epsilon-1$ are about 20% higher th those calculated from the one-group formula.

13888

NEUTRON ABSORPTION BY CONTROL RODS OF VARYING TRANSPARENCY. H.Überall.

Nuclear Sci. Engng (USA), Vol. 7, No. 3, 228-34 (March, 1960).

Neutron fluxes and currents in the vicinity of control rods inside reactors are calculated in age-diffusion theory, using a control rod in the form of an infinite plane slab and approximat its transparency by a simple analytical expression. The result are compared with a two-group calculation for the same geome and indicate the degree of accuracy of the latter method. The comparison is made for epithermal neutron energies only, and shows that in this region, two-group theory is applicable for a calculation of the number of neutrons absorbed by the control r with a fair accuracy.

13889

A USEFUL ANALOGY FOR SINGLE-GROUP NEUT DIFFUSION THEORY. J.R.Melcher.

Nuclear Sci. Engng (USA), Vol. 7, No. 3, 235-9 (March, 1960).

It is shown that an analogy exists between the neutron flux predicted by a single-group neutron diffusion theory and the ax component of the electric field intensity in a field excited as a plane transverse-magnetic wave in a cylindrical cavity. The buckling of a homogeneous bare core could be determined usin simple microwave devices to an accuracy on the same order a the uncertainty of the cavity dimensions. Experimental techni are described for measuring control rod worth for fully extend cylindrical control rods of arbitrary cross-section and illustra solutions are shown for circular, hexagonal, square, cruform, "Y" and sheet cross-sections located at the centre and at radia positions in a circular core. A method is described for predic the flux distribution in the core region and experimental examp are shown.

13890

STATIC AND DYNAMIC MULTIPLICATION FACTO AND THEIR RELATION TO THE INHOUR EQUATI

E.E.Gross and J.H.Marable.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 281-91 (April, 1960).

The theory of the stable period of a fixed-fuel reactor is developed by considering the gross conservation of neutrons in reactor. The resulting inhour equation directly relates the dynamic multiplication factor to the actual delayed-neutron fractions. It is shown that the inhour equation may also be wri in terms of the conventional multiplication factor if so-called "effective" delayed neutron fractions are introduced. The resu are shown to be in agreement with those of the perturbation method.

13891

THE DETERMINATION OF THE SIGN OF THE VO COEFFICIENTS OF REACTOR ZONES. H.Dušek.

Nukleonik (Germany), Vol. 2, No. 1, 38-9 (Jan., 1960). In Gern

The general case of a critical system, in which small cavi exist, is considered using multi-group perturbation theory. Conditions sufficient for the occurrence of a positive void coef are obtained and expressions are derived which determine the of a reactivity coefficient of a void in the system. This genera theory is then applied, for two neutron groups, to a cylindrical reactor with rotational symmetry and various zones radially. Results are presented for the particular cases of a heavy-wate region in, and for the insertion of part of the lattice of the Sie natural-uranium heavy-water reactor into, an Argonaut reactor.

A.J.Sa

13892

NUMERICAL CALCULATION OF HETEROGENEO REACTORS. F.Stummel.

Nukleonik (Germany), Vol. 2, No. 5, 178-92 (Sept., 1960).
In German.

In the vicinity of a fuel rod the flux can be expressed as a Fourier series. The mean value equation, which is satisfied b flux in the moderator and the Fourier coefficients of the flux a surface of a rod, are derived from the two-group diffusion equat

ylindrical reactor. A similar equation is also obtained for the
it the reactor boundary. From these equations a finite set of
r equations for the flux and Fourier coefficients is obtained;
igenvalue problem can then be solved by iteration methods. A
er of examples are given to illustrate the method. D.H.Lord

893 THE REACTIVITY EFFECT OF CAVITIES BETWEEN THE FISSION ZONE AND REFLECTOR BY THE P_L
ROXIMATION OF THE TRANSPORT EQUATION.

aendörfer and M.Ritzi.
eonik (Germany), Vol. 2, No. 6, 247-52 (Nov., 1960).
erman.

The monoenergetic transport equation is solved by the P_1, P_2
P_3-approximations for a spherical core, separated from a re-
or by a cavity. These solutions show that the effect of the cavity
ven accurately enough by the P_1-approximation. The two-group
tion is also solved by the P_1-approximation. A comparison of
$_L$-perturbation and rigorous P_L calculations shows that the
irbation calculations yield good results for centres up to thick-
es of 0.04 of the core radius. D.H.Lord

3894 EXACT MULTIGROUP DIFFUSION THEORY OF THE FINITE HETEROGENEOUS, LAMINATED REACTOR.

ldekop.
eonik (Germany), Vol. 2, No. 6, 252-4 (Nov., 1960).
erman.

The form of the n group diffusion equations general solution is
ved for a finite, heterogeneous, lamina reactor. The flux
atures λ_K^2 are given by an n-th degree equation, as for homo-
ous reactors. The critical conditions for an empty reactor with
dd number of cells is like that for the homogeneous reactor i.e.
$= \pi/L$, where L is the system's length and λ_0 is the imaginary
of the characteristic equation. D.H.Lord

3895 ESTIMATION OF THE HEATING OF NEUTRONS IN Be CANS. A.Müller.

eonik (Germany), Vol. 2, No. 7, 277 (Dec., 1960). In German.

An approximate formula (Abstr. 11504 of 1959) for the heating
homogenized cylindrical fuel element is quoted. This is then
ied to a reactor with 19 fuel rods of UO_2 canned in Be, with
cooling. D.H.Lord

3896 CRITICALITY ESTIMATES FOR SPHERES AND SLABS. T.W.Mullikin.

. Nat. Acad. Sci. USA, Vol. 47, No. 3, 349-51 (March, 1961).

In the theory of neutron transport, the determination of the
ical mass of a reactor is reduced to a determination of the
tral radius of a linear integral operator T. The operator T is
ined by passing from the steady-state transport equation for the
ron angular distribution to an integral equation for the neutron
. At one stage in this transformation, T is represented as an
gral of a one-parameter family of compact self-adjoint operators
se spectral resolution is known. This is used to obtain upper-
d estimates on the spectral radius of T, i.e., lower-bound
mates for the critical mass. This is done for spheres and slabs
er the assumption of monoenergetic neutrons and isotropy of the
ision-fission process. A numerical example is given for a bare
as evidence of the accuracy of the bounds. J.F.Hill

3897 THE REACTOR AS A SOURCE OF RADIATION. A.J.Salmon.

. J. appl. Phys., Vol. 12, No. 10, 537-44 (Oct., 1961).

The experimental facilities and the intensities of the radiations
h are now available in research reactors are surveyed and
e of the characteristics discussed of the various reactor types
terest to the radiation worker. The types and numbers of
eral purpose research reactors now available throughout the
ld are also indicated, and some particular applications of
ctors for research are described.

13898 ENRICHED-URANIUM HYDRIDE CRITICAL ASSEMBLIES.

.Linenberger, J.D.Orndoff and H.C.Paxton.
lear Sci. Engng (USA), Vol. 7, No. 1, 44-57 (Jan., 1960).

Critical assemblies reported here consist of approximate
eres of enriched-uranium hydride composition (approximating
) in 8 in. thick normal uranium and nickel reflectors and in a
nium reflector with nickel liner. Data are of the following types:
ritical sizes, (2) values of Rossi alpha in the neighbourhood of
yed critical, (3) activation rates of various internal neutron
ectors, and (4) reactivity coefficients of a variety of elements.
From the reactivity coefficients at various radial positions, changes in critical mass corresponding to small changes in composition and density are computed.

13899 NEUTRON ENERGY SPECTRUM MEASUREMENTS IN UNMODERATED ASSEMBLIES. G.J.Fischer.

Nuclear Sci. Engng (USA), Vol. 7, No. 4, 355-62 (April, 1960).

The neutron energy spectrum at the centre of the dilute fast core of the coupled fast-thermal reactor, ZPR-V was studied by use of fission chambers having electrodes quantitatively electro-deposited with U^{234}, U^{235}, U^{236}, and U^{238}. Atomic fission ratios found with these four uranium isotopes determine a four-group neutron energy spectrum which can readily be measured as a function of position in the core by use of suitable drive units. The same fission chamber procedure was used to study the equilibrium neutron energy spectrum in a natural uranium exponential column at Los Alamos. The results of measurements in these two spectra are shown and compared with theoretical predictions. The ZPR-V results are also compared to an analysis of this spectrum made by use of nuclear emulsions for the range 0.2 to 2.2 MeV.

13900 THE TREATMENT OF RESULTS IN REACTOR CONTROL. E.Picard.

Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p. 291-6. In French.

Describes a system of supervising the activity of the cooling gas in nearly 1200 channels. For routine analysis the channels are grouped four at a time and twelve detectors sample each group every 24 minutes. After subtraction of the background noise, the activity G is compared with $G_0\alpha$, G_0 being the activity measured at a reference time, and α being a factor which takes account of the life of the reactor and thus reduces the risk of false alarms of sheath rupture. An alarm is given when $G - G_0$ reaches a threshold value E'. At the same time control signals are sent to the valves of four suspect channels, which are then sampled individually and continuously. All values are stored and comparisons made in an electronic computer. W.G.Stripp

13901 NUMERICAL PROCEDURE FOR DETERMINING [THE TEMPERATURE] OF REACTOR COOLING CHANNELS WITH ARBITRARY DISTRIBUTION OF THERMAL SOURCES IN THE FISSION PRODUCT ELEMENT. W.Strewe.

Atomkernenergie (Germany), Vol. 5, No. 4, 134-41 (April, 1960). In German.

If the thermal emission distribution of a fission product element is merely given, after measurements, in the form of a table or diagram it is impossible to calculate the behaviour of the cooling system temperature and of the surface temperature of the fission element. In these cases a procedure is suggested which enables one with only a few calculations to estimate the temperature variations numerically. If the entrance and exit temperature of the cooling medium and the maximum surface temperature of the fission element are given, the appropriate values can be determined for the lay-out of the cooling channel. The procedure is developed for the simple case where the thermal transistion from the cooling medium to the moderator can be disregarded, and also taking the transition into account. Examples illustrate the respective calculations. An evaluation of the errors involved is given in conclusion.

13902 [COOLANT] FLOW INVERSION IN GAS-COOLED REACTORS. H.Benzler.

Atomkernenergie (Germany), Vol. 5, No. 5, 165-72 (May, 1960). In German.

In a gas-cooled reactor with downward coolant flow, recirculation may occur in some cooling channels. It is shown that there is a rather broad region of partial load, in which inverse flow is self-sustaining. However, in the larger part of that region a normal downward flow cannot change to the adverse direction.

13903 THE EXPERIMENTAL DETERMINATION OF THE BUCKLING IN THE BARE HEAVY WATER NATURAL URANIUM CRITICAL ASSEMBLY "RB".

N.M.Raišić, D.D.Popović, S.M.Takač and M.M.Đorđević.
Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 1-6 (March, 1960).

The buckling of the heavy-water natural uranium critical assembly at the Boris Kidrich Institute, Belgrade was determined by measuring the thermal neutron flux distribution. The value obtained for the critical buckling at 20°C was $B^2 = (8.516 \pm 0.02)\,m^{-2}$. The error is a statistical one, obtained from several series of measurements. The possible systematic error was estimated as $0.1\,m^{-2}$.

13904 PRECIPITATOR MONITOR DETECTS FUEL FAILURES. A.C.Lapsley.
Nucleonics (USA), Vol. 19, No. 5, 74, 76 (May, 1961).

A gas sample from a nuclear reactor passes through a precipitator consisting of a cylindrical tube maintained positive with respect to an axial SS wire 0.0055 in. in diameter, which is continuously moved past a shielded stilbene scintillation counter. Solid daughter nuclei resulting from β-decay are deposited on the wire and subsequent decays detected by the β-counter. The detector has a high sensitivity to fission products, but is insensitive to neutron activation products. R.D.Smith

13905 IRRADIATION OF URANIUM MONOCARBIDE. F.A.Rough, A.W.Hare, R.B.Price and S.Alfant.
Nuclear Sci. Engng (USA), Vol. 7, No. 2, 111-21 (Feb., 1960).

Uranium carbide containing about 5.2 wt% carbon was irradiated to nominal burnups of 1000 and 5000 MWd/ton of carbide to evaluate it as a fuel material for sodium-cooled reactors. The results are generally encouraging, although some cracking was observed. The observed density decreases were about the same at 1000 and 5000 MWd/ton irradiations, being 0.7 to 2.5 and 0.6 to 2.5% respectively. The problems and questions raised by these irradiations are discussed.

13906 THE CRYSTAL SPECTROMETER OF THE EL3 PILE. R.Genin, R.Joly and M.Ribrag.
J. Phys. Radium (France), Vol. 21, No. 5, 473-4 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The crystal spectrometer used at the EL3 pile is briefly described, in particular the automatic arrangement for fixing the complete experimental programme on a perforated tape. Preliminary measurements on the variation of the ternary fission of U^{235} with the incident neutron energy are reported.

13907 A PNEUMATIC IRRADIATION DEVICE FOR THE
MEASUREMENT OF THERMAL NEUTRON FLUX
A PILE. P.Mulot, R.Poussot and A.P.Schmitt.
J. Phys. Radium (France), Vol. 21, Suppl. No. 7, 79A-86A (July, 1960). In French.

An apparatus for making absolute measurement in the cor
of the EL3 reactor at Saclay by means of activation detectors
described. The apparatus consists of a pneumatic transfer sy
provided with solenoid valves whose sequence of operation is
electronically controlled according to a predetermined progra
A timing device measures the irradiation time (at the location
the measurement) and transit times (in and out of the reactor
of the detector and its support. The system works with compr
gas (at 6 kg cm^{-2} in the present case). It is capable of measur
thermal neutron fluxes up to 10^{15} n cm^{-2} sec^{-1} owing to the shor
transfer times achieved, and the nature of the Pb—Au alloy us
as detector. The results of measurements performed in the E
reactor are given as an example.

13908 MEASURING REACTOR NEUTRON SPECTRA WIT
THRESHOLD DETECTORS. R.J.Grader.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 933-5 (Aug., 1961).

The use of threshold detector foils to measure the externa
neutron spectrum of two reactors is described. The foils emp
are Pu^{239} to measure the total fast flux, U^{238} for the region abo
1.5 MeV, S^{32} above 2.5 MeV and Au^{197} for thermal neutrons.
Scintillation counters are used to determine the activity induce
in the detectors. The foil-counting system is calibrated by usi
a Cockroft—Walton accelerator as a fast-neutron source. The
results indicate a fission-type spectrum at each reactor.

FAST CHOPPER FOR REACTOR NEUTRON SPECTRA. See Abstr. 13448

PLASMA PHYSICS AND THE PROBLEM OF CONTROLLE
THERMONUCLEAR REACTIONS. See Abstr. 13077

ATOMIC AND MOLECULAR PHYSICS

13909 AN ELECTRONIC COMPUTER (B.E.S.K.) PROGRAM FOR ONE-ELECTRON TWO-CENTRE INTEGRALS OF HARTREE—FOCK SELF-CONSISTENT FIELD FUNCTIONS IN ANALYTICAL FORM.
E.Forslind, S.Forsén and A.Rupprecht.
Ark. Fys. (Sweden), Vol. 18, Paper 39, 563-8 (1960).

13910 MODEL OF A QUANTUM HARMONIC OSCILLATOR WITH FRICTION IN DISPERSION THEORY.
L.A.Shulman and N.Yu.Deinker.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 455-9 (1958). In Ukrainian.

The Hamiltonian of a quantum harmonic oscillator with friction interacting with an incident light wave is determined. The Hamiltonian obtained is applied to develop a dispersion theory with absorption. The calculation yields an expression for the automatic polarization of the system as a function of the frequency.

13911 THE DENSITY MATRIX IN MANY-ELECTRON QUANTUM MECHANICS. II. SEPARATION OF SPACE AND SPIN VARIABLES; SPIN COUPLING PROBLEMS.
R.McWeeny and Y.Mizuno.
Proc. Roy. Soc. A (GB), Vol. 259, 554-77 (Jan. 24, 1961).

For Pt I, see Abstr. 9728 of 1960. The spin-independent properties of an electronic system are completely determined by spinless density functions, $P_1(1;1')$ and $P_2(1,2;1',2')$, derived from the 1- and 2-electron density matrices, $\rho_1(1;1')$ and $\rho_2(1,2;1',2')$. These functions, and their physical interpretation, have been dealt with in Part I: the present paper contains the generalizations necessary when the Hamiltonian contains spin terms (as in discussions of electron and nuclear spin resonance). The density matrices, and more generally the transition density matrices $\rho_1(\kappa\lambda|1;1')$ and $\rho_2(\kappa\lambda|1,2;1',2')$ associated with states Φ_κ and Φ_λ, are resolved into spinless components associated with different spin situations: ρ_1 has four such components (one giving the density of α-spin electrons, a second the density of β-spin electrons, and two with less direct physical significance), while ρ_2 has sixteen components. It is shown that all components, for states $\kappa=(S,M)$, $\lambda=(S',M')$ of given S,S', are determined by three 2-electron
functions. For $\kappa=\lambda$ these reduce to: P_2, the spinless pair func
from which the electron density P_1 may be derived by integrati
Q_2, a "conditional" spin density, from which the (1-electron) s
density Q_1 may be derived (as in the case of P_1 and P_2); $Q_{c.a.}$,
" coupling anisotropy function", which describes the anisotropy
spin—spin coupling associated with quantization of the spin z-
component. It is also useful to introduce (though it is not an
independent function), Q_C, a "coupling density function", which
measures the coupling between the spins of two electrons at di
points in space. All spin-dependent effects, including the usua
spin-spin and spin-orbit couplings and also (indirect) nuclear
electron-nuclear spin-spin couplings, may be related to the m
electron wave function through the above density functions. Al
densities have a physical interpretation, independent of the pr
nature of the wave functions (which may, for example, be the e
eigenfunctions of a spinless Hamiltonian or merely approxima
of orbital form). The derivation of the density functions from
approximate wave functions is considered in some detail. For
functions describing weakly coupled electron groups (e.g. inne
shell and valence electrons) the densities may be expressed in
terms of those of the separate groups. This reduction may be
followed by an orbital description of each group; and subseque
by a linear-combination-of-atomic-orbitals (l.c.a.o.) approxim
In the simpler approximations, all the coupling effects discuss
are determined by electron and spin "populations". Prelimina
calculations suggest that such approximations may in many ca
be adequate.

13912 THEORY OF ELECTRON CORRELATION IN ATO
AND MOLECULES. O.Sinanoğlu.
Proc. Roy. Soc. A (GB), Vol. 260, 379-92 (March 7, 1961).

Corrections to the Hartree—Fock (HF) wave function, Φ_0,
energy of a many-electron system are given. By the use of op
techniques in perturbation theory, the first-order wave functio
is obtained in terms of pair functions. These satisfy equation
like those of an actual two-electron system, except that now e
electron moves in the HF field of the entire N-electron "medi
added to the field of nuclei. Every pair function must be ortho

ized to each of the two HF orbitals associated with it to get omplete X_1'. This X_1' determines both E_2 and E_3. The second- r energy, E_2, comes out as the sum of pair interactions and - and four-body correlations due to the exclusion principle. atter may be incorporated into the pair energies if each pair ion is orthogonalized also to the remaining HF orbitals of Φ_0. approach allows the valence and inner shells, etc., to be ssed separately and extends some of the concepts of quantum istry based on orbital approximations so as to include elation.

3913 ABSORPTION AND EMISSION OF LIGHT BY A WEAKLY PERTURBED SYSTEM. V.L.Strȳzhevs'kyi.

yin. fiz. Zh. (USSR), Vol. 4, No. 6, 809-10 (1959). In Ukrainian.

ATOMS

3914 INVERSE SOLUTION OF THE THOMAS—FERMI EQUATION. L.Gold.

ys. Soc. Japan, Vol. 15, No. 6, 1132-3 (June, 1960).

The first eight coefficients in the expansion of x in powers -ϕ) are derived, and numerical values are given for the free ral atom. J.Hawgood

13915 THE INVERSE SOLUTION OF THE TFD EQUATION. K.Umeda, Y.Tomishima and C.Kawabata.

hys. Soc. Japan, Vol. 16, No. 2, 341-2 (Feb., 1961).

Extension to the TFD case of Gold's TF expansion (see eding abstract), with numerical tabulation for the free argon . J.Hawgood

3916 CORRELATION AND QUANTUM CORRECTIONS IN THE THOMAS—FERMI MODEL OF THE ATOM. G.A.Baraff.

s. Rev. (USA), Vol. 123, No. 6, 2087-100 (Sept. 15, 1961).

A new method is described for computing the effect of elation, inhomogeneity, and exchange on the Thomas—Fermi el of the atom. The method makes use of the many-body point ew, rather than an independent-particle point of view, by con- ring the hierarchy equation linking the n-particle Green's tions. The hierarchy is truncated by a prescription equivalent e Gell-Mann and Brueckner theory of the high-density electron resulting in a description of the atom in which the exchange inter- on is replaced by the effective interaction. The physical ificance of this replacement is noted. The Green's function for model is then expanded as a series in powers of ħ. The lowest r term is found to describe the Thomas—Fermi model of the . The equation for the next higher term contributing to this nsion is manipulated so as to yield an ordinary differential tion for the corresponding correction to the potential. This tion contains a term which expresses the effect of inhomo- ity and another which arises from the correlation of the electrons from exchange. The inhomogeneity term is one which has been d previously. Study of the correlation term shows that it nds on the separation energy of an electron from an infinite tron gas, which suggests a generalization by which the method ht be made applicable to those outer regions of the atom for h the electron density is below that to which the Gell-Mann and eckner theory would apply.

13917 TRANSITION PROBABILITIES AND OSCILLATOR STRENGTHS FOR ELEMENTS OF ASTROPHYSICAL EREST. L.Houziaux and M.P.Sadoline.

l. Soc. Roy. Sci. Liege (Belgium), Vol. 30, No. 5-6, 287-99 1). In French.

Transition probabilities and oscillator strengths were com- d for multiplets of 14 elements. The Coulomb approximation used for the computation of the intensity factor σ^2. The inter- tions in the Bates and Damgaard tables (Abstr. 4640 of 1949) computations were carried out with the help of an IBM 650 puter.

13918 DEPENDENCE OF THE ELECTRON SHELL DIMENSIONS ON THE ATOMIC NUMBER OF THE ATOM.

.Korol'kov.

ika i Spektrosk. (USSR), Vol. 10, No. 1, 3-7 (Jan., 1961). ussian.

Considers the dependence of the parameters $\bar{r}^k(n,l)$ on the mic number and the degree of ionization of an ion; here $\bar{r}$ is the mean radius of a given electron shell. This dependence was used to calculate the quantities $\bar{r}^k(4f)$ for rare-earth ions with k = -3, +1, +2, +4, +6. The results are in good agreement with experiment. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 1-3 (Jan., 1961)]. A.Tybulewicz

13919 AN EXPANSION METHOD FOR CALCULATING ATOMIC PROPERTIES. M.Cohen and A.Dalgarno.

Proc. Roy. Soc. A (GB), Vol. 261, 565-76 (May 23, 1961).

An expansion method is described which provides a simple and rapid means of calculating for any atom the expectation values of sums of one-electron operators. All the equations which arise can be solved analytically and the results are obtained as functions of the nuclear charge. For inner shells the accuracy is comparable with that of the Hartree—Fock approximation. The method gives a quantitative description of the effects of direct and exchange interactions between electron shells. Results are given for all members of the helium and beryllium iso-electronic sequences.

13920 RELATIVISTIC SELF-CONSISTENT FIELDS. I.P.Grant.

Proc. Roy. Soc. A (GB), Vol. 262, 555-76 (Aug. 8, 1961).

The equations of the relativistic self-consistent field, first set up by Swirles (1935), are discussed using the algebra of tensor operators. The coefficients of radial integrals in the formula for the energy can be written in terms of Clebsch—Gordon and Racah coefficients, so that their symmetries can easily be seen and their numerical values can easily be calculated with the use of published tables. The magnetic interaction between two electrons is considered as well as the electrostatic interaction, and the effect of this term on the ionization energy of a K electron in mercury is computed with the use of unpublished results of Mayers.

13921 THE EFFECT OF EXCHANGE AND CORRELATION ON BINDING ENERGY OF COMPRESSED ATOMS. M.P.Kawatra.

Progr. theor. Phys. (Japan), Vol. 25, No. 6, 888-94 (June, 1961).

In the binding energy formula the effect of exchange is taken by making use of the Thomas—Fermi—Dirac function. Correlation is incorporated as a perturbation and the effect of a finite boundary is taken as given by Scott (Abstr. 9001 of 1952). The agreement between the calculated values and the experimentally observed ones is much better than provided by Scott.

13922 REMARK ON THE VARIATIONAL CALCULATIONS OF THE POLARIZABILITY. M.N.Adamov and V.A.Zubkov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 246-8 (Jan., 1961). In Russian.

It is shown that in constructing the trial function for the variational calculation of the polarizability of an electron in an excited state it is necessary to take into account the orthogonality of the perturbed wave-functions. The polarizabilities of the excited states of an electron in a hydrogen atom or a one-dimensional infinitely deep potential well calculated with account of the above-mentioned orthogonality condition are in satisfactory agreement with the exact values (approaching them from below). [English translation in: Soviet Physics-JETP (USA), Vol. 13, No. 1, 169-70 (July, 1961)].

13923 A NEW DERIVATION OF SCHMIDT'S FORMULA. N.J.Ionescu-Pallas.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 4, 639-42 (1959). In Roumanian.

A new consistent derivation of Schmidt's correction is made, starting from Dirac's Energy Levels formula. To this purpose, a suitable transformation allows Dirac's formula applicability to heavy alkali-like atoms. Finally, the fine structure splitting is obtained in terms of r^{-3} mean value and Q correction factor.

13924 SOME RECENT RESULTS ON ELECTRONIC WAVE-FUNCTIONS INVOLVING THE INTERELECTRON SEPARATION r_{12}. S.Besnaïnou.

Cahiers de Phys. (France), Vol. 15, 232-6 (May, 1961). In French.

Recent theoretical work on the ground state of two-electron atoms is summarized. M.R.C.McDowell

13925 THEORY OF ISOTOPE SHIFTS IN HEAVY ATOMS. N.J.Ionesco-Pallas.

Ann. Phys. (Germany), Vol. 8, No. 1-2, 9-27 (1961).

A general theory is given for the isotope shift of energy levels in heavy atoms. The methods used are based neither on the simple perturbation theory nor on the solution of the Darwin—Gordon differential epuations for the region inside the nucleus. It is sufficient to solve an integral equation from which result both the distortion effect of the wave-function due to the spatial extension of the nucleus, and the specific nuclear effects of surface and deformation. The screening effects of the electrons in the closed shells, the effect of nuclear compressibility as well as other effects are also analysed. The main causes which account for the global effect of isotope shift are probably all described. The values obtained theoretically for the isotopic constants of the nuclei, agree fairly well with the experimental ones.

13926 NUCLEAR MAGNETIC SHIELDING OF A HYDROGEN ATOM IN (1) AN ELECTRIC FIELD-GRADIENT AND (2) A CAGE. A.D.Buckingham and K.P.Lawley.
Molecular Phys. (GB), Vol. 3, No. 3, 219-22 (May, 1960).

The ground state wave-function of a hydrogen atom in an electric field-gradient F' is obtained, correct to the first power in F', and the nuclear magnetic screening constant σ evaluated. The F' contribution to σ vanishes if all directions of F' relative to the applied magnetic field are equally probable. Secondly, the influence of a uniform compression of the H-atom on σ is examined. This effect, which will predominate at sufficiently high pressures, causes a decrease in the electronic polarizability but an increase in σ.

13927 HYPERFINE STRUCTURE OF THE METASTABLE $^{3}P_{2}$-STATE OF Kr^{83} BY THE ATOMIC BEAM RESONANCE METHOD. H.Kuiper and H.Friedburg.
Naturwissenschaften (Germany), Vol. 48, No. 3, 69 (1961).
In German.

Measurements were made with a magnetic atomic beam resonance apparatus, of which brief details are given. Atoms in th metastable $^{3}P_{2}$-state were obtained from a gas-discharge source with Kr^{83} enriched to 45% and conserved by closed-circuit circulation. The transitions $F = 9/2$, $m = 7/2 \rightleftharpoons F = 11/2$, $m = 5/2$ and $F = 11/2$, $m = 9/2 \rightleftharpoons F = 13/2$, $m = 7/2$ were measured, and the separations of the $F = 9/2$, $11/2$ and $13/2$ levels derived by extrapolation to zero magnetic field, with accuracies better than one in 10^{5}. The nuclear spin of Kr^{83} is confirmed as 9/2. The magnetic-dipole and electric-quadrupole coupling constants are evaluated, and from the latter the nuclear quadrupole moment of Kr^{83} is calculated (no details given) as $+(0.249 \pm 0.008) \times 10^{-24}$ cm^{2}, without Sternheimer correction. J.Sheridan

13928 AUTO-IONIZATION OF THE $(1s2s2p)^{4}P_{5/2}$ LEVEL IN Li AND He^{-}. J.L.Pietenpol.
Phys. Rev. Letters (USA), Vol. 7, No. 2, 64 (July 15, 1961).

The lifetime of this state for auto-ionization by a magnetic spin—spin interaction process is estimated to be 1.6×10^{-5} sec for Li and 1.7×10^{-3} sec for He^{-}. J.Hawgood

13929 A CALCULATION OF THE R_{lk}-INTEGRALS FOR THE GROUND STATE OF THE LITHIUM ATOM. H.Aden.
Ann. Phys. (Germany), Vol. 8, No. 1-2, 28-30 (1961). In German.

A systematic method for evaluating three-electron Coulomb interaction integrals is outlined. All angular factors are expanded into spherical harmonics and reduced with the help of orthonormality relations. The remaining radial integrals are converted into triple sums and evaluated through truncation. T.Erber

13930 ATOMIC WAVE FUNCTIONS FOR THE GROUND STATES OF Na^{+}, Ne, AND F^{-}. W.E.Donath.
J. chem. Phys. (USA), Vol. 35, No. 3, 817-20 (Sept., 1961).

Calculations of wave-functions for the 'S ground states of Na^{5}, Ne, and F^{-} which essentially correlate the outer shell are presented. The "root" function in each case is an analytic Hartree—Fock function. The improved 13-configuration function yields an improvement in energy of about 50% of the estimated correlation energy.

ELECTRON BREMSSTRAHLUNG IN THE FIELD OF A NEUTRAL ATOM. See Abstr. 13384

13931 FORBIDDEN LINES IN ATOMIC SPECTRA. L.A.Borisoglebskii.
Uspekhi fiz. Nauk (USSR), Vol. 66, No. 4, 603-52 (Dec., 1958).
In Russian.

Review, mainly theoretical. Discusses the importance of forbidden lines with low transition probability in astro- and plasma-physics and in crystals. Selection rules and Zeeman theory for multipole radiation under LS coupling are given for spontaneously
forbidden lines with detailed emphasis on multiplet structure
electric quadrupole and magnetic dipole lines. Collision exci
of forbidden lines in celestial bodies, polar aurora and night s
seems more effective than photo-ionization or fluorescence m
isms in the former two cases. Calculations of electron excita
cross-sections and transition probabilities are discussed and
individual forbidden lines in systems containing from 1 to 19 e
trons (e.g., H I and Ni XII respectively) are deduced and analy
from possible transitions. Rules for identifying lines induced
electric and magnetic fields are discussed. Experimental diff
ties for laboratory production of lines, the importance of data
line width and intensities and the use of observations from
satellites are briefly noted. Most examples are from atomic
spectra in the optical region, with a few from molecular and t
from the radiowave region. 166 refs. [English translation in:
Soviet Physics - Uspekhi (USA), Vol. 1 (66), No. 2, 211-44
(Nov.-Dec., 1958)]. L.Bo

13932 ON RELATIVE DOUBLET LINE STRENGTHS IN T PRINCIPAL SERIES OF CESIUM. W.Hanus.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland),
No. 4, 287-91 (1961).

The deviation of the doublet intensity ratio from the value
can be explained by spin—orbit interaction. The author uses t
formulae of Fermi (1930) to calculate these ratios and uses m
similar to those of Fermi for finding the radial integrals. A c
parison is given of experimental and theoretical results, inclu
including those of other workers. G.H.C.Fr

13933 A STUDY OF THE EMISSION INTENSITIES OF Cr FROM SHOCKED GASES CONTAINING $Cr(CO)_{6}$.
S.H.Bauer, J.H.Kiefer and B.E.Loader.
Canad. J. Chem., Vol. 39, No. 5, 1113-30 (May, 1961).

Argon—nitrogen mixtures (9/1) were inoculated with trace
$Cr(CO)_{6}$ (0.026%) and shocked to temperatures in the range 350
5700°K. The intensities of a violet line ($^{7}P_{2} \rightarrow {}^{7}S_{3}$) and a triple
green lines ($^{5}P_{3,2,1} \rightarrow {}^{5}S_{2}$) were measured concurrently, with a
channel spectrograph. Exclusive of runs for which $T > 5000$°K
variation of intensity with temperature was brought to agreeme
with theoretical predictions under the assumption that the N_{2} v
tions, the dissociation of $Cr(CO)_{6}$, and the ionization of Cr atta
their equilibrium states, but allowance had to be made for self
absorption. The dependence of the rise times on temperature
that the excitation and ionization of Cr is predominantly due to
collisions with electrons. The overall shapes of the recorded
pulses were qualitatively accounted for. It is suggested that ex
eous background radiation contributed to the measured intensit
samples shocked to temperatures above 5000°K.

13934 DISPLACEMENT OF THE 2537 A LINE OF MERC BY HYDROGEN AND DEUTERIUM.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3216-18 (May 24,
In French.

The displacement of the absorption line is different for de
ium and hydrogen. This difference can be explained by a term
the interaction equation between mercury and the hydrogen
(Abstr. 4889 of 1961) which depends on the reduced mass of the
couple. G.H.C.Fre

13935 CALCULATION OF THE SHAPE OF THE MERCUR RESONANCE LINE BROADENED BY ARGON, BAS ON THE THEORY OF JABLONSKI. S.Legowski.
J. Phys. Radium (France), Vol. 22, No. 3, 154-8 (March, 1961).
In French.

It was assumed that the interaction potential is of the
Lennard-Jones [12-6] type. Potential parameters were determ
from thermodynamic and spectroscopic data given in the litera
The theoretical calculations were compared with Michel's expe
mental data. The shape determined is in close agreement with
observed.

13936 INFLUENCE OF TEMPERATURE ON THE BROADENING OF THE MERCURY RESONANCE L BY XENON. T.Skaliński, J.Rogaczewski and M.I.Kapuścińska.
Bull. Acad. Polon, Sci. Ser. Sci. math. astron. phys. (Poland),
No. 4, 265-9 (1960).

The absorption of the mercury line (2537 A) as a function
temperature, and hence as a function of the number of collision
agrees with theory up to 1000°K but deviates at higher tempera
The asymmetry and the exponent m, from the formula $I(\nu) \sim (\nu_{0}$
after Kuhn (1937), both change with temperature. The intensity

ition in the long-wave wing of the line shows absorption bands h are tentatively identified as part of the vibration spectra of nolecule Hg—Xe. G.H.C.Freeman

13937 DIRECT MEASUREMENT OF THE HYPERFINE STRUCTURE OF THE 6 $^3P_1$ LEVEL OF THE NUCLEAR

MER Hg^{197*}. C.Brot.

hys. Radium (France), Vol. 22, No. 7, 412-16 (July, 1961).

rench.

The hyperfine interval F = 13/2 → F = 11/2 in the 6 $^3P_1$ state ie nuclear isomer Hg^{197*} was measured using a recently loped double resonance method. This method depends on the rvation of the wavelength change of the light re-emitted after r.f. transition. The result obtained has a probable error of it 6×10^{-6}.

3938 THE EFFECT OF POLAR MOLECULES ON THE ABSORPTION AT THE RESONANT MERCURY LINE

2537 A. V.I.Ivanov.

ka i Spektrosk. (USSR), Vol. 9, No. 5, 553-6 (Nov., 1960).

ussian.

Gives a technique and results of a study of the absorption ctra of the gaseous systems Hg/NO, Hg/CO, Hg/H_2O. An ysis of the fall of intensity in the long-wavelength wing and of half-width of the line gave the effect of the dipole moment of perturbing molecule (NO, CO, H_2O) on the absorption by mercury ns. In the case of interaction with NO, the half-width and the nsity fall were strongly temperature-dependent because the le moment of NO varied with temperature. [English translation Optics and Spectrosc.(USA), Vol. 9, No. 5, 293-4 (Nov., 1960)]. A.Tybulewicz

13939 NEW AFTERGLOW EMISSION ASSOCIATED WITH METASTABLE NITROGEN ATOMS.

erman and R.Herman.

ire (GB), Vol. 191, 346-7 (July 22, 1961).

A new example of atomic recombination involving excited nitro- atoms is reported. The experiment is performed using a dis- rge tube containing xenon with a small admixture of very pure ogen. The discharge and afterglow spectra are observed using nventional pulse technique and a rotating disk in such a fashion both spectra may be recorded simultaneously. Results show the afterglow spectra are not much excited during the discharge that there is a semi-continuous band system of about the same nsity in both the discharge and afterglow spectra, suggesting that afterglow is associated with some slow reaction. Various pro- ses to account for this emission are suggested. M.Kasha

13940 NEW INTERPRETATION OF THE ZEEMAN EFFECT IN Mn I.

arcía-Riquelme, R.Velasco, R.Oyarzun and F.Veas.

Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 5-6, 137-50 y-June, 1960). In Spanish.

Zeeman patterns of 314 lines of Mn I were measured. Corres- ding energy levels of the neutral Mn atom were deduced and are orded in tabular form. R.W.Fish

13941 ORIGIN OF THE Kβ'-LINE ACCORDING TO THE ANGULAR MOMENTUM COUPLING HYPOTHESIS.

lorák.

ch J. Phys., Vol. 10, No. 5, 405-6 (1960).

Calculations are reported which indicate that this line in the ay spectrum of iron-group elements can be explained by Coster Druyvesteyn's hypothesis (1927) of interaction of the incomplete shell with inner X-ray vacancies. The calculations, on Mn^{2+} and $^+$ ions, used both simple Slater orbitals and Hartree—Fock itals. J.Hawgood

13942 EMISSION SPECTRA OF FLAMES SUPPORTED BY ACTIVE NITROGEN. K.R.Jennings and J.W.Linnett.

ans Faraday Soc. (GB), Vol. 56, Pt 12, 1737-41 (Dec., 1960).

Visible and u.v. emission spectra of flames produced by roducing 16 substances into a stream of active nitrogen were otographed. The CN red and violet systems are the most promi- it features of the spectra of flames given by hydrocarbons and hough the CH 4315 A band is present, the CH 3889 A band is not served. A complex group of heads in the region of 3290 A was o observed in the spectrum of hydrocarbon flames and this is tatively assigned to the cyanogen molecule or to a species med from it.

13943 OBSERVATIONS OF THE SECOND POSITIVE SYSTEM OF NITROGEN IN THE REACTIONS OF ATOMIC NITROGEN WITH SOME ALIPHATIC AMINES; ASSIGNMENT OF A NEWLY IDENTIFIED BAND TO THE (5,5) TRANSITION.

G.Pannetier, L.Marsigny and H.Guenebaut.

C.R.Acad. Sci. (France), Vol. 252, No. 12, 1753-5 (March 20, 1961). In French.

In the reaction of free nitrogen atoms with aliphatic amines, the bands of the second positive system with v' = 3 and 4 are preferentially emitted and a new (5,5) band is observed at 3259.2 A. These are apparently the same as the unassigned bands near 3290 A recently reported by Jennings and Linnett (see preceding abstract). A.G.Gaydon

13944 SPECTRA INDUCED BY 200 keV PROTON IMPACT ON NITROGEN. R.H.Hughes, J.L.Philpot and C.Y.Fan.

Phys. Rev. (USA), Vol. 123, No. 6, 2084-6 (Sept. 15, 1961).

Spectra induced by 200 keV proton impact on nitrogen were observed in the spectral region from 3000 A to 6000 A. The principle feature was the strong excitation of the N_2^+ first negative band systems. Absolute cross-sections for excitation were determined for the principal bands of this system as well as for two N II atomic lines. A relatively weak Doppler-shifted H_β line was detected, and the cross-section for the charge-exchange electron-capture into the n = 4 excited state of hydrogen was estimated. Second positive N_2 bands were observed at higher pressures.

13945 LINES OF THE N V SPECTRUM IN THE VISIBLE AND NEAR ULTRA-VIOLET WAVELENGTH REGIONS.

R.Hallin and T.P.Hughes.

Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 201-3 (Aug., 1961).

Measured wavelengths of several N V lines emitted from the toroidal gas-discharge apparatus SCEPTRE III are given. For hydrogenic transitions they agree closely with the predictions of a polarization formula due to Edlén (1961). Observations of 6—7 transitions are compared with those reported by Lukianov and Sinitsyn (Abstr. 8005 of 1958) which, being made at higher pressures, were probably more strongly influenced by Stark effect. The possibility of using the Stark effect in high quantum number transitions in Li sequence atoms such as C IV, N V or O VI for density measurements is discussed briefly.

13946 COMPARISON STUDY OF THE L EMISSION BANDS OF PALLADIUM. C.Bonnelle and C.Senemaud.

C. R. Acad. Sci. (France), Vol. 253, No. 1, 95-8 (July 3, 1961). In French.

Differences between the $L\beta_2$ and $L\gamma_1$ emission bands of Pd are interpreted in terms of spin-coupling between the 4d energy levels. J.Thewlis

13947 ZEEMAN EFFECT IN THE GROUND MULTIPLET OF SAMARIUM. F.M.J.Pichanick and G.K.Woodgate.

Proc. Roy. Soc. A (GB), Vol. 263, No. 1312, 89-100 (Aug. 22, 1961).

The values of g_J for all the levels of the ground term ^7F of samarium were measured by the method of magnetic resonance in an atomic beam. These are

J	gJ	J	gJ
1	1.49840 ± 0.00005	4	1.49625 ± 0.00004
2	1.49779 ± 0.00003	5	1.49533 ± 0.00006
3	1.49707 ± 0.00003	6	1.49419 ± 0.00010

A theoretical calculation of some of the corrections to the Landé g-value is presented. These corrections arise from the breakdown of Russell—Saunders coupling and from relativistic and diamagnetic effects. While the numerical agreement with experiment appears superficially to be good, it is shown, by a consideration of the J-dependence of the theoretical corrections, that certain significant discrepancies remain. A new measurement of g_J for the ground state of europium is also reported and discussed. It is $g_J(Eu\,^8S_{7/2} = 1.99340 \pm 0.00007$.

13948 THE SECOND SPECTRUM OF SILICON.

A.G.Shenstone.

Proc. Roy. Soc. A (GB), Vol. 261, 153-74 (April 25, 1961).

New observations of the spectrum Si II from λ 700 to λ 9500 are described, 300 lines being listed in addition to those previously assigned to this spectrum. The analysis includes details of the perturbations of the $3s^2nx\,^2X$ series up to x = g. Structures of type $3s3p(^3P)nx$ up to x = f have been identified and many peculiarities found. A large proportion of the levels show auto-ionization effects, even up to a term at 25 000 cm^{-1} above ionization. The same term also shows an anomalous degree of excitation in the hollow cathode for two levels which cannot auto-ionize.

13949 SPECTRUM AND TERM SYSTEM OF DOUBLY IONIZED SILICON, Si III. Y.G.Toresson.

Ark. Fys. (Sweden), Vol. 18, Paper 28, 389-416 (1960).

The spectrum of doubly ionized silicon, Si III, was investigated in the region from 10 000 A to 400 A. About 360 lines were measured and identified and 107 new energy levels established. A number of intersystem combination lines, of which $3s^{2\,1}S_0-3s3p\,^3P_1$ falls at λ_{vac} 1892.030 A, fix the singlet and triplet systems in relation to each other. The ^1G level of 3sng falls within the narrow range (~1 cm^{-1}) of the ^3G levels, and the four levels of 3snh, 3sni, etc. are coincident within the limits of the observations. A consistent system of term values was derived, and accurate wavelengths in the vacuum region were calculated from the term system. The ionization energy was determined from the series 3s6h, 7h, and 8h, and found to be 270 139.3 ± 0.4 cm^{-1}.

13950 VACUUM ULTRAVIOLET SPECTRUM OF THE NEUTRAL SULPHUR ATOM, S I. Y.G.Toresson.

Ark. Fys. (Sweden), Vol. 18, Paper 29, 417-20 (1960).

The strong S I lines in the vacuum ultraviolet region were measured, and the values of some deep terms were revised by use of the new measurements. The level $3s3p^{51}\ P_1$ was found, and the difference $^1D - {}^1S$ in $3s^23p^4$ accurately determined.

13951 CONTRIBUTION TO THE STUDY OF L SPECTRA EXCITED BY ELECTRONIC BOMBARDMENT OF SOME HEAVY ELEMENTS: INTENSITY RATIOS AND THEIR VARIATION AS A FUNCTION OF Z. C.Victor.

Ann. Phys. (France), Vol. 6, No. 1-2, 183-210 (Jan.-Feb., 1961).
In French.

A curved crystal method was used to determine the intensities of X-ray L spectra in terms of the actual number of photons present. The ratios of the intensities of the L spectra for W, Pt, Au, Pb, Bi, Th and U were then determined and compared with those arising from nuclear transmutations. It was found that the probability of excitation of the three L sub-levels varies with the mode of excitation: internal conversion, electron capture and external bombardment all giving rise to different values. A study was also made of the relationship between intensity and atomic number. J.Thewlis

13952 INTENSITY RATIOS OF SPECTRAL LINES IN THE SHARP SERIES TRIPLETS OF ATOMS OF THE SECOND COLUMN OF THE PERIODIC TABLE.

Z.Leś and H.Niewodniczański.

Acta phys. Polon. (Poland), Vol. 20, No. 8, 701-14 (1961).

The intensity ratios of the lines of the following triplets were measured:

Zn I: $(4s4p\,^3P^0_{2,1,0}-4s5s\,^3S_1)$ 4810, 4722, 4680 A,
$(4s4p\,^3P^0_{2,1,0}-4s6s\,^3S_1)$ 3072, 3036, 3018 A, and
$(4s4p\,^3P^0_{2,1,0}-4s4d\,^3D)$ 3345, 3303, 3282 A;
Cd I: $(5s5p\,^3P^0_{2,1,0}-5s6s\,^3S_1)$ 5086, 4800, 4678 A, and
$(5s5p\,^3P^0_{2,1,0}-5s8s\,^3S_1)$ 2868, 2775, 2734 A;
Hg I: $(6s6p\,^3P^0_{2,1,0}-6s7s\,^3S_1)$ 5461, 4358, 4047 A.

Various conditions of excitation were used; arc, spark, electrodeless excitation and a Schüler-type hollow-cathode lamp. Photographic methods of mono- and heterochromatic spectrophotometry were employed. The measurements yielded intensity ratios in the ultraviolet that were in agreement with the sum rules, whereas those obtained for the visible triplets of Zn I, Cd I and Hg I were at variance with these rules. The greatest divergence occurs in Hg and the smallest in Zn; the intensity ratios in the visible triplet of Cd I vary strongly with the conditions of excitation. All divergences from the theoretical values are readily explained by reabsorption related to the metastable states $^3P^0_0$ and $^3P^0_2$. From these considerations, the discussion of results obtained by different authors in measuring the intensity ratios of spectral lines in triplets of the sharp series of atoms of the second column of the periodic system leads to the conclusion that these ratios obey the rule of sums and that reabsorption is solely responsible for the divergences found.

13953 RELATIVE OSCILLATOR STRENGTHS OF SOME Zn I AND Cd I LINES. N.P.Penkin and T.P.Red'

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 680-2 (Nov., 1960).
In Russian.

The relative oscillator strengths of 30 Zn I and Cd I lines the lower levels $^3P_{0,1,2}$, were determined by a modified Rozhdestvenskii's "hooks" method. The results were general good agreement with those reported by other workers and with calculated values. [English translation in: Optics and Spectro (USA), Vol. 9, No. 5, 360 (Nov., 1960)]. A.Tybu

13954 MEASUREMENT OF THE ABSOLUTE OSCILLATO STRENGTHS OF THE RESONANCE LINES OF CALCIUM, STRONTIUM AND BARIUM IONS.

Yu.I.Ostrovskii and N.P.Penkin.

Optika i Spektrosk. (USSR) Vol. 10, No. 1, 8-14 (Jan., 1961).
In Russian.

Rozhdestvenskii's "hooks" method was used to measure t absolute oscillator strengths (f) of the resonance doublets of C at 3933 A (f = 0.78) and 3968 A (f = 0.40), of Sr II at 4078 A (f and 4215 A (f = 0.39) and of Ba II at 4554 A (f = 0.70) and 4934 (f = 0.35). The results were confirmed by measurements of th f_{3933}/f_{4554} and f_{4078}/f_{4554} ratios in mixtures of vapours. The res confirm Saha's formula to within 20%. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 3-6 (Jan., 1961)]. A.Tybule

13955 FIRST IONIZATION POTENTIAL OF ELEMENTS CHARACTERIZED BY THEIR ELECTRONS OF T OUTER SHELLS (1 TO 7). R.Aynard.

C.R. Acad. Sci. (France), Vol. 252, No. 23, 3568-70 (June 5, 1
In French.

Semi-empirical formulae for the first ionization potential elements with outer 1s, 2s or np (n = 1 to 6) electrons are pre ed, giving the ionization potential in terms of the total number s and of p electrons. An extrapolation for the 7p shell suggest that for atomic number 113 the ionization potential is about 10 M.R.C.McI

13956 FIRST IONIZATION POTENTIAL OF ELEMENTS CHARACTERIZED BY THEIR s AND p ELECTRO OF THE OUTER SHELLS (1 TO 7). VALUES CALCULATED THE EXPRESSION $E_i(s,p)$ AND CORRESPONDING CURVES.

R.Aynard.

C.R. Acad. Sci. (France), Vol. 252, No. 24, 3760-2 (June 12, 1
In French.

The expression given in the preceding abstract is applied obtain numerical values; these are compared with experiment plotted as curves, and discussed. See also Abstr. 11477-9 of J.Ha

13957 FIRST IONIZATION POTENTIAL OF ELEMENTS CHARACTERIZED BY THEIR f, d AND s ELECT OF THE INNER SHELLS (3 TO 7). R.Aynard.

C.R. Acad. Sci. (France), Vol. 252, No. 25, 3949-51 (June 19,
In French.

Semi-empirical formulae for the first ionization potentia terms of the total number of d electrons are presented. Extr tion to element 113, with 37 d electrons, yields approximately 10.5 eV for its ionization potential, in agreement with the res of a previous extrapolation (see two preceding abstracts). M.R.C.Mc

13958 ON THE RELATION BETWEEN HANLE'S EXPER MENT AND OPTICALLY-INDUCED SPIN PRECE APPLICATION TO THE STUDY OF EXCITED ATOMIC STAT

A.Kastler.

C. R. Acad. Sci. (France), Vol. 252, No. 16, 2396-8 (April 17,
In French.

An optical resonance experiment is proposed in which the exciting light consists of pulses repeated at the Larmor frequ of the atoms in the excited state, in an applied magnetic field. coherent precession of the spins of the excited atoms is produ giving rise to a modulation of the resonance radiation. The e disappears if the pulse repetition rate differs from the Larmo frequency. The connection with the phenomenon of depolariza of resonance radiation by a magnetic field is discussed. E.F.W.Se

.3959 RADIATIVE TRANSITION PROBABILITIES OF THE LOWER EXCITED STATES OF THE ALKALI METALS.

Heavens.
pt. Soc. Amer., Vol. 51, No. 10, 1058-61 (Oct., 1961).

Lifetimes for radiative transitions between the lower excited es of atoms of the alkali metals have been calculated by using central field approximation used by Bates and Damgaard (Abstr. of 1949). Branching ratios for downward transitions and total imes of states are tabulated.

3960 THE EXCITATION BY COLLISION OF THE TRANSITION 4s—3d of Ca$^+$. H.van Regemorter.

. Acad. Sci. (France), Vo. 252, No. 18, 2667-9 (May 3, 1961).
rench.

The calculation of the quadrupole cross-section for the transi- 4s → 3d using the Coulomb—Born method is presented. The lts are compared with those obtained when using the Bethe oximation and when account is taken of the coupling with the 4p transition. See Abstr. 3506 of 1961. G.H.C.Freeman

13961 APPROXIMATE WAVE FUNCTIONS IN THE CALCULATION OF [ATOMIC] ELECTRON EXCITON ACCOMPANYING THE BETA-DECAY OF He^6.

olos.
a phys. Polon. (Poland), Vol. 20, No. 2, 175-8 (1961).

The probability of non-excitation of atomic-electrons in the -decay of He^6 was calculated using approximate wave-functions uding the self-consistent field ones. The results are signifi- ly different from those obtained with wave-functions which give e accurate values of the energy.

.3962 CROSS-SECTION FOR EXCITATION OF IONIZED MAGNESIUM BY ELECTRON IMPACTS.

an Regemorter.
. Acad. Sci. (France), Vol. 252, No. 17, 2514-16 (April 24, 1961).
rench.

The Coulomb—Born method with coupling is applied to the sition 3s-3p in Mg II. The results are compared with those ained with Bethe's method which is shown to overestimate the ss-section by a factor four when the coupling between atomic es is assumed to be weak. K.A.Thomas

13963 OPTICAL PUMPING AND THE DENSITY MATRIX FORMALISM. J.P.Barrat and C.Cohen-Tannoudji.

hys. Radium (France), Vol. 22, No. 6, 329-36 (June, 1961).
rench.

A detailed treatment is given of the absorption and emission of onance radiation by a group of atoms. The radiation is treated ntum-mechanically, and the density matrix formalism is used to cribe atoms in the ground and excited states. It is shown that effect of optical excitation is to give the ground state a finite time and a self-energy. Differential equations are derived which cribe the effect of the different steps of the optical pumping le on the density matrix in the ground state.

13964 ENLARGEMENT AND DISPLACEMENT OF MAGNETIC RESONANCE RADIATION CAUSED BY AN OPTICAL CITATION. J.P.Barrat and C.Cohen-Tannoudji.

Phys. Radium (France), Vol. 22, No. 7, 443-50 (July, 1961).
French.

The total effect of absorption and emission of resonance iation in the ground state of an ensemble of atoms is derived from ations established in an earlier paper (see preceding abstract). se equations are put in a simpler form by means of a "secular roximation" which is satisfied in all practical cases. The effect radiofrequency field is taken into account. Some of the results ained are: description of optical pumping as a relaxation process he ground state; possibility of a partial conservation of coherence ing the pumping cycle; prediction of some shifts of the magnetic onance lines under the influence of the optical excitation; ex- ssion for the optically detected signals as a function of the ments of the density matrix in the ground state.

MEASUREMENT OF WEAK MAGNETIC FIELDS BY OPTICAL MPING METHODS. See Abstr. 13148

13965 SCATTERING OF ELECTRON BY THOMAS—FERMI POTENTIAL. S.C.Mukherjee.

ian J. Phys. Vol. 35, No. 4, 165-9 (April, 1961).

The elastic scattering cross-section of electrons by the Thomas—Fermi potential, as represented by the analytical forms due to Gombas (1949) and Tietz (Abstr. 9025 of 1955; 3559 of 1959) is calculated by the Born approximation method. The results are in fair agreement with those calculated with the exact numerical form of the Thomas—Fermi potential. Further comparison shows that the Gombas—Tietz form is as good as those of Rozental (1935) and Buchdahl (Abstr. 6088 of 1956).

13966 SCATTERING OF ELECTRONS BY A SCREENED COULOMB FIELD IN HIGHER BORN APPROXIMATION.

T.K.Mitra.
Indian J. Phys., Vol. 35, No. 6, 278-81 (June, 1961).

The relativistic scattering of electrons by heavy atoms is studied by taking the Rozental approximation of the Thomas—Fermi potential. The differential cross-section of scattering is calculated in the Born approximation up to second order in the expansion of $Ze^2/\hbar v$. The numerical results of the scattering of electrons of energy 150 KeV at an angle 90° are given for the elements A, Kr, Xe, and Hg.

13967 THE SCATTERING OF ELECTRONS BY ATOMIC HYDROGEN. M.H.Mittleman.

Ann. Phys. (USA), Vol. 14, No. 1, 94-106 (July, 1961).

A method is presented which reduces the problem to the scattering of a single electron in an equivalent potential. The complexities of the electron—electron interaction are embodied in this potential. An exact expression is given for the potential, and various approximation methods are discussed. The adiabatic approximation is investigated and the imaginary part of the potential is examined.

13968 ELASTIC SCATTERING OF FAST ELECTRONS BY THE HELIUM ATOM AND THE INTERELECTRONIC CORRELATION. M.Inokuti.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 717-19 (April, 1961).

The sensitivity of the Born approximation for the zero-angle elastic scattering to the choice of bound state wave function is examined. A correlation factor of the form $(1 + \gamma r_{12})$ is used to modify both the unsymmetrized one-parameter and properly symmetrized two-parameter functions normaly employed. The improvement of the agreement with the observed value reported by Huzinaga (Abstr. 3519 of 1961) on adopting the antisymmetrized function is slightly reduced by including correlation.
M.R.C.McDowell

SCATTERING OF LOW-ENERGY ORTHO-POSITRONIUM BY HYDROGEN ATOMS. See Abstr. 13403

13969 SCATTERING OF GALLIUM ATOMS IN DIFFERENT ZEEMAN STATES.

K.Berkling, C.Schlier and P.Toschek.
Z. Naturforsch.(Germany), Vol. 15a, No. 9, 838-9 (Sept., 1960).
In German.

Gallium atoms in two different Zeeman states $^2P_{3/2}$, $m_J = +\frac{3}{2}$ $m_J = +\frac{1}{2}$ were scattered from noble gases and the relative difference in effective collision cross-sections $\Delta\sigma/\sigma$ was measured and compared with theoretical predictions. Typical values of $\Delta\sigma/\sigma$ are found to be $\sim 10^{-3}$. P.M.Parker

13970 CATALYTIC MAGNETIZATION OF ATOMIC HYDROGEN? S.Doniach.

Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 806-8 (Nov. 1, 1960).

An experiment is envisaged which uses ferromagnetic material as a catalyst to produce spin-oriented protons. Surface-adsorbed hydrogen atoms when escaping from the ferromagnetic surface utilize the high spin entropy of the ferromagnetic state to polarize their electrons. The polarization is shared with the protons through the hyperfine coupling. Conditions under which such a mechanism may operate successfully are described. P.M.Parker

Isotopes

13971 A SPECTROSCOPIC ANALYSIS OF THE ISOTOPIC COMPOSITION OF LITHIUM.

A.N.Zaidel', A.N.Razumovskii and M.P.Chaika.
Optika i Spektrosk. (USSR), Vol. 10, No. 1, 15-18 (Jan., 1961).
In Russian.

Describes a spectroscopic analysis of the isotopic composition of lithium based on measurements of the intensities of the compon-

ents of a resonance doublet at 6707.8 A. A hollow-cathode discharge source was used. The spectrum was recorded with a Fabry—Perot etalon. The sensitivity of the method was about 0.5%Li^6. The errors were represented by a coefficient of variation of 0.15-0.7% for Li^6 contents from 40 to 90%. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 7-9 (Jan., 1961)].
A.Tybulewicz

13972 STUDY OF THE ISOTOPIC EFFECT ON THE COURSE OF THE ELECTROMIGRATION OF LITHIUM IN VITREOUS SILICA.

J.Pauly.
C.R. Acad. Sci. (France), Vol. 252, No. 16, 2407-10 (April 17, 1961). In French.

The electromigration of lithium ions in a surface of vitreous silica was determined at temperatures between 350° and 810°C. The isotopic separation factor is higher than that obtained on a monocrystal and is close to the theoretical value of the ratio of the square roots of the isotopic masses. G.I.W.Llewelyn

13973 A STUDY OF IONIC CONTAMINATION IN ELECTROMAGNETIC ISOTOPE SEPARATORS. APPLICATION TO THE PRODUCTION OF HIGH PURITY ISOTOPES.

J.Camplan, M.van Ments and R.Bernas.
J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 91A-99A (June, 1961). In French.

A magnetic analysis of the contamination was made through the use of the second stage of a double magnetic deflection isotope separator. The study showed that, besides gas scattering, a non-negligible part of contamination was due to low-energy ions. These phenomena account for a large part of the asymmetry of contamination which is generally observed in isotope separators. Some methods for improving the performance of existing machines are suggested.

13974 ISOTOPIC CONTAMINATION IN ELECTROMAGNETIC ISOTOPE SEPARATORS.

C.Cassignol.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 192-208 (1960). In French.

The isotopic purity of the nuclides prepared by electromagnetic separation of isotopes is never complete, owing to isotopic contamination. The physical bases of isotopic contamination are set out in the first part of this paper. After examining some trivial mechanisms, and proving that no initial energy spreading of the ions is responsible for contamination, the principal mechanisms are considered. These are scattering and instability of the ion sources, the characteristics of both are studied in detail. An unique schema of contamination is then built up by condensing the latter partial mechanisms, and direct experimental confirmation is obtained.

13975 SURFACE-IONIZATION ION SOURCE FOR THE SEPARATION OF ISOTOPES OF ALKALI METALS.

V.I.Raiko, M.S.Ioffe and V.S.Zolotarev.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 29-32 (Jan.-Feb.). In Russian.

A source of K or Rb ions for electromagnetic isotope separators is described. Potassium metal (or RbCl) is loaded into a directly-heated furnace and the vapour thus produced is passed over a hot nickel surface at which surface ionization takes place. The ions are then extracted and focused into a beam. The ion beam current is independent of the temperature of the surface ionizer above ~ 1200°K. Ion currents up to ~ 120 mA can be obtained. Compared with gas-discharge sources, the present device has the advantage that the effect of oscillatory processes on the ion beam is excluded and the beam does not contain multiply-charged particles. S.Chomet

13976 THERMAL DIFFUSION IN D_2—HT AND OTHER HYDROGEN MIXTURES.

J.Schirdewahn, A.Klemm and L.Waldmann.
Z. Naturforsch. (Germany), Vol. 16a, No. 2, 133-44 (Feb., 1961). In German.

The thermal diffusion coefficients α of HT and DT in D_2 and of HT in H_2 were measured in a Clusius—Dickels separation tube. In order to avoid exchange, the gas was allowed contact only with glass, mercury and tap grease and its maximum temperature was 230°C. The results were: $\alpha(D_2, HT) = 0.028$; $\alpha(HT, H_2) = 0.11 < \alpha(D_2, H_2)$; $\alpha(DT, D_2) = 0.042$; the molecule named first being the one that goes to the hot side. The large value for the pair D_2/HT of equal molecular weight is remarkable. The results can be expressed by $\alpha_{12} = 0.25(m_1-m_2)/(m_1+m_2) + 0{\cdot}20(\Theta_1-\Theta_2)/(\Theta_1+\Theta_2)$, where m = mass and Θ = moment of inertia of the molecule. H.London

APPROXIMATIONS FOR THE ISOTOPIC THERMAL DIFF FACTOR. APPLICATION TO HELIUM ISOTOPES. See Abstr

13977 THE SEPARATION OF HYDROGEN, DEUTERIUM HYDROGEN DEUTERIDE MIXTURES BY GAS CHROMATOGRAPHY.

P.P.Hunt and H.A.Smith.
J. phys. chem. (USA), Vol. 65, No. 1, 87-9 (Jan., 1961).

The resolution and analysis of the components of hydroge deuterium mixtures was accomplished by gas chromatography 77°K. Neon was employed as the carrier gas, and the column chromia deposited on alumina. Orthohydrogen and parahydrog not separate on the chromia—alumina column. The separation for hydrogen deuteride and deuterium was much greater than hydrogen and hydrogen deuteride. The complete separation of terium and hydrogen deuteride was also obtained on a silica ge column with hydrogen as the carrier gas, whereas a charcoal column produced very little separation.

Mesic Atoms

13978 ENERGY LEVEL SHIFTS IN ATOMIC STATES OF STRONGLY-INTERACTING PARTICLES.

T.L.Tr
Nuclear Phys. (Internat.), Vol. 26, No. 1, 57-67 (July, 1961).

The energy-level displacements for atomic states of two oppositely-charged nuclear particles due to their strong intera are related to the parameters of the effective range approxima for the low-energy scattering of these two particles. For s- a p-states, the level shift and width are obtained to third order i A/B (scattering length A divided by Bohr radius B). The result are illustrated by a brief discussion of the level shifts and life of the K^- — p and K^- — d systems.

13979 THEORETICAL VALUES FOR MAGNETIC MOMEN OF μ-MESONIC ATOMS.

K.W.Ford, V.W.Hughes and J.G.Wills.
Phys. Rev. Letters (USA), Vol. 7, No. 4, 134-5 (Aug. 15, 1961).

The corrections to the gyromagnetic ratio of the muon bou a spin-zero nucleus and surrounded by a spin-zero electron cl are calculated. Results are tabulated for C^{12}, O^{16}, Mg^{12}, Si^{14}, S
A.Ash

NUCLEAR POLARIZATION IN A MESIC DEUTERIUM ATC
See Abstr. 13628

MOLECULES

13980 FORCE CONSTANTS OF PHOSPHORUS TRICHLOF

V.Lorenzelli.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3219-20 (May 24, 1 In French.

Spectral results on gaseous PCl_3 in the far infrared regio are used to calculate force constants for the molecule assumin C_{3v} pyramidal structure. G.I.W.Lle

13981 POTENTIAL CONSTANTS AND CALCULATED TH DYNAMIC PROPERTIES OF NITRYL FLUORIDE AND NITRYL CHLORIDE.

P.G.Puranik and E.V.Rao.
Indian J. Phys., Vol. 33, No. 4, 177-82 (April, 1961).

Using a most general quadratic potential energy expressio the molecules NO_2F and NO_2Cl are subjected to normal coordi treatment. Two sets of 13 force constants for each molecule a proposed, and the fundamental frequencies are calculated with help of Wilson's F-G matrix method. The calculated and the observed values of the frequencies agree closely. Thermodyna properties for the fluoride and chloride are calculated for tem tures in the range 100-1000°K.

13982 F-G MATRIX ELEMENTS FOR PYRAMIDAL XY_2Z MOLECULES.

P.Babu Rao and K.Sreeramamurty
Indian J. Phys., Vol. 34, No. 9, 434-7 (Sept., 1960).

Matrix elements are calculated using the most general ha force field. R.A.Bal

1983 FORCE CONSTANTS OF THE URANYL ION BY WILSON'S F-G MATRIX METHOD. K.V.Narasimham.
n J. Phys., Vol. 34, No. 9, 432-3 (Sept., 1960).
alculations of F_d, F_{dd}, F_α and $F_{d\alpha}$ are made for both the and linear structures. R.A.Ballinger

3984 CALCULATION OF FORCE FIELD AND INTERPRETATION OF VIBRATION SPECTRA OF METHYL HOL (CH_3OH, CH_3OD, CD_3OH AND CD_3OD).
argottin-Maclou.
ys. Radium (France), Vol. 21, No. 8-9, 634-44 (Aug.-Sept.,). In French.
The valence force field of methyl alcohol has been determined a harmonic potential hypothesis. The calculation is carried ccording to Wilson's method (1939), completed by an iteration od. From the calculated force field, the vibration frequencies H_3OH, CH_3OD, CD_3OH and CD_3OD were obtained with a mean r of 0.5% relative to the observed frequencies in the gaseous . The use of the "energy localization" criterion as a basis for otation concerning normal modes of vibration is discussed.

13985 VIBRATIONAL ASSIGNMENT AND FORCE CONSTANTS OF S_8 FROM A NORMAL-COORDINATE TREATMENT.
.Scott and J.P.McCullough.
olecular Spectrosc. (USA), Vol. 6, No. 4, 372-8 (April, 1961).
Normal-coordinate calculations were made for S_8 to improve earlier work that had not explicitly included torsional forces t S—S bonds. Inclusion of torsional forces led to a vibrational gnment that is consistent with the spectral and thermodynamic . for S_8.

13986 POTENTIAL ENERGY CONSTANTS, ROTATIONAL DISTORTION CONSTANTS, AND CALCULATED ERMODYNAMIC PROPERTIES FOR SOME PLANAR XYZ_2 LECULES. M.G.K.Pillai and F.F.Cleveland.
olecular Spectrosc. (USA), Vol. 6, No. 5, 465-71 (May, 1961).
A normal coordinate treatment has been carried out for each of molecules $CSCl_2$, $COCl_2$, COF_2, COH_2, and COD_2, using the most eral quadratic potential energy function, the Wilson FG Matrix hod, and the procedure of Gold et al. (Abstr. 6374 of 1958). The ential energy constants obtained were then used to determine the ational distortion constants on the basis of the first-order turbation theory of Kivelson and Wilson. The molar thermoamic properties—heat content, free energy, entropy, and heat acity—also were calculated for 12 temperatures from 100° to 0°K for the ideal gaseous state at one atmosphere pressure and h the usual rigid-rotor harmonic-oscillator approximation.

13987 ISOTOPIC STRUCTURE OF THE ABSORPTION BAND $\nu_1 + \nu_4$ OF CARBON TETRACHLORIDE.
.Verlan, M.P.Lȳsȳtsya and V.L.Strȳzhevskȳi.
ayin. fiz. Zh. (USSR), Vol. 4, No. 5, 606-14 (1959). In Ukrainian.
The force constants of isolated CCl_4 molecules are determined. e frequencies of the fundamental modes are calculated for isoic molecules CCl_4^{35}, $CCl_3^{35}Cl^{37}$, $CCl_2^{35}Cl_2^{37}$, $CCl^{35}Cl_3^{37}$ and CCl_4^{37}. eir values are applied to find the frequencies of type $\nu_1 + \nu_4$ nbinations. A comparison of the results obtained with experiment ws that the structure of the $\nu_1 + \nu_4$ vibration band of gaseous bon tetrachloride is completely determined by the isotopic itting of the latter.

13988 ON A METHOD OF EVALUATION OF THE ANHARMONICITY OF POLYATOMIC MOLECULES. M.Rytel.
ta phys. Polon. (Poland), Vol. 19, No. 3, 273-5 (1960). In French.
The author assumes that the anharmonicity constant η is same for similar vibrations of isotopic molecules. He can then culate values of η for valency and bending vibrations of H_2O, O and D_2O, using the observed frequencies of Benedict, Gailar Plyler (Abstr. 5780 of 1956). Frequencies calculated back m these constants accord also with other observations and with observations of Staats, Morgan and Goldstein (Abstr. 4998 1956) on T_2O, DTO and HTO. G.F.Lothian

13989 ELECTRONIC TRANSITION MOMENT VARIATION AND VIBRATIONAL TEMPERATURE.
R.Tawde and N.S.Murthy.
rrent Sci. (India), Vol. 30, No. 6, 216-17 (June, 1961).
Previous measurements (Abstr. 20601 of 1960) on the spectrum BeO excited in a carbon arc were used to derive the vibrational temperature. If the transition moment is assumed constant T = 4840° K, but if variation of moment with internuclear distance is allowed for then T = 4000° K. A.G.Gaydon

13990 TWO-FOLD DEGENERATE SIMPLE HARMONIC OSCILLATOR: RADIAL MATRIX ELEMENTS OF 1 AND r^{-1}. J.H.Waggoner, Jr and W.H.Shaffer.
J. molecular Spectrosc. (USA), Vol. 6, No. 4, 363-71 (April, 1961).
The generating function for associated Laguerre polynomials is used to obtain general expressions for the two-fold degenerate simple harmonic oscillator radial matrix elements of 1 and r^{-1}. The nonvanishing matrix elements of 1 for the cases $l' = l \pm 2$, which occur in certain spectral line intensity calculations, are worked out.

13991 WAVE FUNCTIONS AND INTENSITY CALCULATIONS FOR A ROTATING ANHARMONIC OSCILLATOR.
T.C.James.
J. chem. Phys. (USA), Vol. 35, No. 3, 767-73 (Sept., 1961).
Wave-functions which are good through second-order perturbation theory are given for a harmonic oscillator perturbed by a potential of the form $V = \hbar w(ax + bx^2 + cx^3)$. These results are then applied to the case of a rotating anharmonic oscillator. Expressions are also given for overlap integrals $\langle \bar{n}|m \rangle$ between different unperturbed harmonic oscillator wave-functions. A brief comparison of this treatment with similar treatments is given and a discussion of rotation-vibration interaction is non $^1\Sigma$ states is included. The application to intensity calculations in electronic and infrared spectra is discussed. An approximate expression for the dipole moment matrix element $\langle 1J'|u|0J \rangle$ is given.

13992 THE PERTURBATION OF THE ROTATION—VIBRATION BANDS OF SOME COMPRESSED POLAR DIATOMIC MOLECULES AND THE BLOCKING OF ROTATION BY "ORBITING PAIRS". H.Vu.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 53, 313-64 (Dec., 1960). In French.
The changes induced by variation of pressure and temperature in the fundamental vibration—rotation bands of polar diatomic molecules (HCl, HBr, HF, CO) in the presence of varying amounts of foreign atoms and molecules (He, A, H_2, O_2, N_2, CO, CO_2) were studied. (Pressure range from zero to the density of the solid forms; temperature range -195 to 255°C). With increase in pressure and the consequent phase changes the P-R doublet, with its fine structure, tends to disappear, being replaced by a strong central Q-branch. The shift of this Q-branch, as a function of the density of the perturbing species, and also the effect of temperature on the profile of the band were studied. The experimental data are interpreted as being due to a coupling of the kinetic and Van der Waals forces between an absorbing molecule and one of the foreign species present, combined with an orientation effect which effectively blocks the free rotation of the absorbing molecule. Good agreement is found between the theoretical predictions and the experimental results. W.J.Orville-Thomas

THE TEMPERATURE DEPENDENCE OF THE VIBRATIONAL ABSORPTION BAND INTENSITIES OF GASES. See Abstr. 12928

13993 COORDINATES FOR THE GROUP VIBRATION METHOD FOR CALCULATING MOLECULAR FREQUENCIES. H.L.McMurry.
J. molecular Spectrosc. (USA), Vol. 6, No. 5, 439-46 (May, 1961).
The group vibration method treats large molecules as assemblages of groups of atoms and uses for coordinates displacements of the atoms within each group relative to axes for the group, and rotational and translational displacements of the groups as units. An earlier treatment by the author (Abstr. 8711 of 1959) assumes the use of principal axes for the groups, and for the molecule as a whole. This restriction is sometimes inconvenient and is shown to be unnecessary. The relatively simple changes which are required when other than principal axes are used are described. Criteria are given which serve as a guide to the selection of coordinates for calculating the vibrational frequencies. For the case of symmetrical molecules a relatively simple method of choosing these coordinates is outlined. Some results obtainable on this method are given for symmetrical linear normal paraffins.

13994 CALCULATION OF INERTIA DEFECT. I. GENERAL FORMULATION. T.Oka and Y.Morino.
J. molecular Spectrosc. (USA), Vol. 6, No. 5, 472-82 (May, 1961).
A general formula for the inertia defect of a molecule is

presented following Nielsen's theory of vibration—rotation interaction. The expression is simplified by the use of the general properties of the 1 matrix which transforms the normal coordinates to the Cartesian coordinates. The effects due to the centrifugal distortion and the electronic interaction are also taken into account. Some examples of the calculation are given for H_2O- and H_2CO-type molecules.

13995
CENTRIFUGAL DISTORTION IN PLANAR MOLECULES.
J.M.Dowling.
J. molecular Spectrosc. (USA), Vol. 6, No. 6, 550-3 (June, 1961).

The rotational distortion of a general asymmetric top molecule is described by six rotational distortion constants which are functions of nine constants appearing in the first-order Hamiltonian for the nonrigid rotor. It is shown that for the case of a planar asymmetric top molecule these nine constants reduce to four, so that the centrifugal distortion of a planar asymmetric top molecule can be described by four constants rather than the usual six. It is also shown for planar symmetric top molecules that only two constants are required to describe the centrifugal distortion effects, rather than the usual three.

13996
THE AVERAGE RULE COMPARED WITH THE COMPLETE ISOTOPIC RULE FOR VIBRATIONAL FREQUENCIES.
W.J.Lehmann.
J. molecular Spectrosc. (USA), Vol. 7, No. 1, 1-13 (July, 1961).

Vibrational frequencies of deuteroethylenes, deuterodiboranes, fluorochloroethylenes, and methyldiboranes are calculated by adaptations of the Complete Isotopic Rule (CIR) and the recently formulated Average Rule (AR). Schematic diagrams are used to illustrate application of the Average Rule for determining the various frequencies of partially deuterated ethylenes, such as the in- and out-of-phase stretching frequencies of cis-$C_2H_2D_2$. Although in its original formulation the Average Rule dealt only with stretching vibrations, it is here applied to bending modes as well. Its simplicity and ease of application make the Average Rule very attractive, even though the more elegant CIR, when applicable, not unexpectedly yields somewhat better results. In many instances, particularly for stretching frequencies, both methods yield equally good results. The Average Rule, however, should generally not be used for averaging widely separated frequencies, especially of bending modes.

13997
IRREDUCIBLE REPRESENTATIONS OF LINE GROUPS.
I.V.V.Raghavacharyulu and C.B.Shrestha.
J. molecular Spectrosc. (USA), Vol. 7, No. 1, 46-52 (July, 1961).

The irreducible representations of one-dimensional space groups (line groups) with one-, two-, and three-dimensional motives are obtained.

13998
AN INTERPRETATION OF POTENTIAL INTERACTION CONSTANTS IN TERMS OF LOW-LYING EXCITED STATES.
R.F.W.Bader.
Molecular Phys. (GB), Vol. 3, No. 2, 137-51 (March, 1960).

Examines the use of second-order perturbation theory in the interpretation and prediction of the signs of the interaction constants which are appended to the simple valence force potential functions. It is shown, for the large number of molecules considered here, that complete agreement with the observed signs can be obtained by expanding the electronic Hamiltonian in terms of the normal coordinates of motion and by then assuming that the lowest of the excited electronic states makes the most important contribution to the second-order sum in the expression for the energy. A knowledge of the symmetry of the transition density between the ground and the first excited electronic states is thus sufficient to determine which of the vibrations in a molecule is energetically favoured and thus to determine the sign of the interaction constant.

13999
A NORMAL CO-ORDINATE TREATMENT OF THE PLANE SYMMETRICAL $A_2B_2C_2D_2$ MOLECULE.
S.S.Mitra and S.K.Joshi.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 617-25 (Nov. 26, 1960).

The classical vibration problem for the plane symmetrical (trans) $A_2B_2C_2D_2$ molecule (Point group C_{2h}) is solved. The F and G matrix elements for the various symmetry species of the system corresponding to the most general harmonic force field are worked out using Wilson's method (1939).

14000
MEAN AMPLITUDES OF VIBRATIONS IN PYRAMIDAL XY_3-TYPE MOLECULES ($X = N, P, As, Sb$; $Y = H, D, T$).
S.Sundaram.
J. molecular Spectrosc. (USA), Vol. 7, No. 1, 53-7 (July, 1961).

The theory of the determination of the mean square amplitudes of vibration of pyramidal XY_3 molecules using the symmetry co-ordinates is given. Analytical expressions for the various mean square amplitude quantities in terms of the mean square amplitu matrix elements (Σ) are derived. The method is applied to the ca ation of the principal mean amplitudes of several XY_3 ($X = N, P,$ $Y = H, D, T$) molecules at 25° C using their vibrational frequencie The results should be of great interest for electron diffraction investigations.

14001
USE OF $\nu = f(Z_X)$ CURVES IN THE STUDY OF VIBRATIONAL SPECTRA OF TETRAHEDRAL MOL-CULES AND IONS OF $X(Hal)_4$ TYPE.
I.N.Godnev and A.M.Aleksandrovskaya.
Optika i Spektrosk. (USSR), Vol. 10, No. 1, 27-32 (Jan., 1961).
In Russian.

A study of the dynamic parameters of neutral $X(Hal)_4$ molecules and isoelectronic ions provided an explanation of the regularities in $\nu = f(Z_X)$ curves which are used to predict vibrational frequencies (ν) of ions. Here X denotes an element of gro IV with an electronic configuration s^2p^2, Hal denotes a halogen a Z_X is the atomic number of X. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 14-16 (Jan., 1961)].

A.Tybulev

14002
VIBRATIONAL TRANSITION IN MOLECULAR COLLISION. IV. ANOTHER SHORT TABLE OF FUNCTIONS USEFUL FOR CALCULATING THE VIBRATIONAL TRANSITION PROBABILITY. (PT I).
K.Takayanagi and S.Kanek
Sci. Rep. Saitama Univ. A (Japan), Vol. 3, No. 3, 167-78 (1960).

For Pt III see Abstr. 9782 of 1961. The energy-dependence the vibrational transition cross-section comes mainly from the translational matrix element. This energy-dependent factor, averaged over the Maxwellian velocity distribution, is tabulated. The matrix elements of the intermolecular potential with respect to the vibrational eigenfunctions are assumed to be of the Morse type.

14003
EFFECT OF FREE ROTATION IN MOLECULES ON THE NORMAL VIBRATION FREQUENCIES.
B.L.Livshits.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 145-51 (Feb., 1961).
In Russian.

The functional dependence of the vibrational operator $\hat{W}^1$ on internal rotation coordinates of polyatomic molecules is establis In the first approximation of a perturbational method an express is obtained for the frequency of a normal vibration as a function an internal rotation coordinate. [English translation in: Optics Spectrosc. (USA), Vol. 10, No. 2, 73-6 (Feb., 1961)].

14004
ROTATIONAL ANALYSIS OF SOME COPPER CHLORIDE [CuCl] BANDS.
A.Lagerqvist and V.Lazarova-Girsamof.
Naturwissenschaften (Germany), Vol. 48, No. 3, 68 (1961). In Ger

The analysis of three bands of the B—X system shows that t transition is $^1\Pi - ^1\Sigma$ (with large Λ-doubling in the $B\,^1\Pi$ state), $\nu_{0,0}$ at 20 476.05 cm^{-1}, and $r_e'' = 2.51$ A. Analysis of the 1—0 band o C—X system shows that state C is $^1\Sigma$.

R.F.Bar

14005
ROTATIONAL STRUCTURE OF THE BAND SPECTR OF CCl MOLECULE.
R.D.Verma and R.S.Mulliken.
J. molecular Spectrosc. (USA), Vol. 6, No. 4, 419-37 (April, 196

The rotational analysis of the band spectrum in the region 2750-2800 A is discussed. The electronic transition involved is proved to be a $^2\Delta$ (Case b) – $^2\Pi$ (Case a) transition, closely anal gous to that of the NO B'—X bands. The principal molecular co stants in cm^{-1} are as follows. For the $^2\Pi$ state, $A = 134.92$; $B_0 =$ 0.6936_3, $B_1 = 0.6869$, $r_e = 1.645_3$; $\omega_e = 875.9$ ($^2\Pi_{1/2}$), 872.3 ($^2\Pi_{3/2}$ $x_e\omega_e = 4.6$ ($^2\Pi_{1/2}$), 3.4 ($^2\Pi_{3/2}$). For the $^2\Delta$ state, $A = -4.219$; $B_0 =$ 0.7062_0, $r_0 = 1.634_4$, $\omega_0 = 865.3 \pm 1.2$.

14006
ROTATIONAL ANALYSIS OF ABSORPTION BANDS OF LEAD MONOXIDE.
R.F.Barrow, J.L.Deutsch and D.N.Travis.
Nature (GB), Vol. 191, 374-5 (July 22, 1961).

The character of six excited states of gaseous PbO were determined and the isotope effect was used to check vibrational analyses. The presence of at least one low-lying $\Omega = 2$ state is suggested by perturbations. It is thought that the states may bes be interpreted as Hund's case-c states. Constants in cm^{-1} for

^{8}O are as follows:

State		$T_{\hat{0}}$	$B_{\hat{e}}$	$10^3\alpha_e$
E	0^+	34 680	(0.238)	(1.4)
D	1	30 464	0.2711	3.1
C^1	1	25 720	0.248	1.8
C	0^+	24 108	0.254	2
B	1	22 531	0.2646_3	2.6
A	0^+	20 088	0.2586_9	1.3_8
X	0^+	0	0.3073_7	2.1_2

R.F.Barrow

007 FLUORESCENCE AND VIBRATIONAL RELAXATION OF NITRIC OXIDE STUDIED BY KINETIC CTROSCOPY.

N.Basco, A.B.Callear and R.G.W.Norrish.
c. Roy. Soc. A (GB), Vol. 260, 459-74 (March 21, 1961).

The first excited vibrational level of the ground electronic es of nitric oxide was populated above its equilibrium value by h photolysis of nitric oxide + inert gas mixtures, under iso- mal conditions.

ctronic excitation

$$NO\,^2\Pi(v = 0) + h\nu \rightarrow NO\,^2\Sigma(v = 0,1,2)$$

followed either by fluorescence

$$NO\,^2\Sigma(v = 0,1,2) \rightarrow NO\,^2\Pi(v = 0,1,2,\ldots) + h\nu,$$

by quenching

$$NO\,^2\Sigma(v = 0,1,2) + M \rightarrow\rightarrow NO\,^2\Pi(v = 0,1,2,\ldots) + M,$$

sing a non-equilibrium population of the vibrational levels of the und electronic states. Subsequently, the reactions

$$NO\,^2\Pi(v = 1) + M \rightarrow NO\,^2\Pi(v = 0) + M$$

$$NO\,^2\Pi(v = 2) + NO\,^2\Pi(v = 0) \rightarrow 2NO\,^2\Pi(v = 1)$$

sed a decay of the vibrationally excited molecules with time; was followed in absorption by kinetic spectroscopy. Because he rapidity of the last reaction, bands of $NO\,^2\Pi$ with $v'' > 1$ were ally observed only in the fluorescence spectrum. In mixtures to 5 mm of NO with a large excess of nitrogen or krypton, the centration of $NO\,^2\Pi(v = 1)$ produced by the flash was of the order 0^{-1} mm pressure, i.e. about the same concentration which is sent in one atmosphere pressure of NO at room temperature. absolute concentration of $NO\,^2\Pi(v = 1)$ was measured accurately late photometry, high pressures of NO being used for calibration. recorded probabilities of vibrational relaxation P_{1-0}, for $\Pi(v = 1)$, and radii for electronic quenching, σ_e, by NO, N_2, CO, and CO_2, are

	P_{1-0}	σ_e(A)
NO	3.55×10^{-4}	14
N_2	4×10^{-7}	$\leq 2 \times 10^{-2}$
CO	2.5×10^{-5}	0.6
H_2O	7×10^{-3}	30
CO_2	1.7×10^{-4}	5

h the use of an analytic form for the flash duration, the entire and fall of the concentration of excited species was quantitat- y interpreted. A very small fraction of the NO was decomposed he flash, due either to absorption of radiation below 1900 A or reaction of metastable NO molecules with each other or with und state molecules. Abnormal effects were observed in + H_2 + inert gas mixtures and chemical reaction occurred.

STRETCHING VIBRATION OF SULPHATE ION IN POTASSIUM LORIDE. See Abstr. 12497

14008 ERRATUM AND ADDENDUM: SUBSTITUTED METHANES. XXIX. VIBRATIONAL SPECTRA, TENTIAL CONSTANTS, AND CALCULATED THERMODYNAMIC OPERTIES FOR DIBROMOCHLOROFLUOROMETHANE AND OMODICHLOROFLUOROMETHANE.

.Gilbert, E.A.Piotrowski, J.M.Dowling and F.F.Cleveland.
hem. Phys. (USA), Vol. 33, No. 6, 1872 (Dec., 1960).

See Abstr. 4207 of 1960.

14009 CARBONYL STRETCHING VIBRATIONS AND ELECTRONIC TRANSITIONS DUE TO NONBONDING ELECTRONS IN SATURATED RING KETONES.

C.N.R.Rao, G.K.Goldman and J.Ramachandran.
J. Indian Inst. Sci., Vol. 43, No. 1, 10-15 (Jan., 1961).

The carbonyl stretching frequency and intensity in saturated ring ketones show marked variations with the ring size. The position of the $n \rightarrow \pi^*$ transition band of the carbonyl group also varies with the ring size. The $n \rightarrow \sigma^*$ bands of the carbonyl group in these compounds have been tentatively assigned.

14010 INTENSITY MEASUREMENTS IN MOLECULAR BANDS.

N.R.Tawde, B.G.Jyoti and M.I.Savadatti.
Indian J. Phys., Vol. 35, No. 6, 307-10 (June, 1961).

Peak and integrated intensities of N_2 II positive bands are measured. The peak values are corrected according to the procedure of Floyd and King (Abstr. 4515 of 1955). The data are obtained with a view to assess the reliability of peak intensity measurements and also the correction due to Floyd and King.

14011 SELECTIVE EXCITATION OF MOLECULAR EMISSIONS BY METASTABLE ATOMS OF RARE GASES.

L.Herman and D.Rakotoarijimy.
J. Phys. Radium (France), Vol. 21, No. 8-9, 629-33 (Aug.-Sept., 1960). In French.

A quantitative study is made of the intensity of the emission spectra of CO and N_2 diluted in rare gases. A selective excitation is obtained in the $d^3\Pi - a^3\Pi$ and $a'^3\Sigma - a^3\Pi$ systems of the CO molecule and in the $B^3\Pi - A^3\Sigma$ system of the N_2 molecule. Selective vibrational levels of the upper electronic states are strongly enhanced. They correspond to the resonance excitation by collision of the metastable X (^{3}P) atoms with the normal CO and N_2 molecules. A check of this hypothesis has been made for CO, using the population distribution instead of the intensity distribution. The relative vibrational transition probabilities of the $d^3\Pi - a^3\Pi$ bands have been calculated by Pillow's method (Abstr. 9812 of 1960). The $v' = 5$ level of the $d^3\Pi$ CO state shows an excess population of about 4 and confirms the existence of a resonance excitation.

14012 ON THE ABSORPTION SPECTRUM OF ICl. II. CHLORINE ISOTOPES IN IODINE CHLORIDE.

E.Hulthén, N.Järlsäter and L.Koffman.
Ark. Fys. (Sweden), Vol. 18, Paper 35, 479-512 (1960).

For Pt I, see Abstr. 7757 of 1960. The transition $A^3\Pi_1 \rightarrow X\,^1\Sigma^+$ was investigated at high resolution, resulting in detailed records of the $^3\Pi_1$ state in ICl^{35} and ICl^{37}. Some close relations were established between the perturbations in the vibrational states of $^3\Pi_1$ and the anomalous behaviour of their recently discovered magnetic rotation. The terminal of the vibrational progression in $^3\Pi_1$ at its limit of dissociation exhibits a remarkable break which is accompanied by a new set of vibrational states, here named X-levels. The dissociation energy of ICl^{35} was determined with high precision. The present investigation is based on extended term-tables of the $^3\Pi_1$ state, given in an appendix.

14013 POSITIONS AND INTENSITIES OF THE ABSORPTION BANDS OF TRYPAFLAVINE AND FLUORESCEIN CATIONS.

B.Żurawski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 11-12, 795-7 (1960).

The wavelengths and, in some cases, the oscillator strengths of the absorption bands of trypaflavine and fluorescein cations were computed by the FEMO method, and compared with the experimental data. The wavelengths, but not the oscillator strengths, are in good agreement with experiment.

J.B.Birks

14014 EMISSION SPECTRA OF THE RADICALS OH AND OD.

L.Herman, P.Felenbok and R.Herman.
J. Phys. Radium (France), Vol. 22, No. 2, 83-92 (Feb., 1961).
In French.

The rotational structure of the (0,6), (0,7), (0,8) and (0,9) OH bands and the (0,8), (0,9), (0,10), (0,11) and (1,11) OD bands of the $B\,^2\Sigma - A\,^2\Sigma$ system was measured with a higher dispersion than previously. New values for the rotational constants of the two levels were found for OH and OD. The observed perturbations are attributed to the predissociation of the upper level, due to dissociation by rotation. This dissociation produces O (^{1}S) atoms which would be responsible for a short continuum in the OD spectrum and lines in the OH spectrum. Two new bands of the $C\,^2\Sigma - X\,^2\Sigma$ system of OH are given.

14015 THE EFFECT OF PARAMAGNETIC MOLECULES ON THE INTENSITY OF SPIN-FORBIDDEN ABSORPTION BANDS OF AROMATIC MOLECULES. J.N.Murrell.

Molecular Phys. (GB), Vol. 3, No. 4, 319-29 (July, 1960).

It is shown that there are two possible mechanisms whereby a singlet—triplet absorption band of a molecule can gain intensity under the perturbing influence of a paramagnetic species. The first involves some mixing of the triplet state with the singlet states of the molecule. The second involves a mixing of the triplet state with charge-transfer states of the complex formed between the molecule and the paramagnetic species. It is shown that in the particular case of an alternant hydrocarbon, the first singlet—triplet absorption band is unlikely to gain intensity by the first of these mechanisms. It follows by elimination that the charge-transfer mechanism is the more important. The available experimental evidence supports this viewpoint.

14016 CHARGE TRANSFER STATES AND OPTICAL ABSORPTION IN OCTAHEDRALLY HYDRATED PARAMAGNETIC SALTS. II. INTENSITIES IN THE MANGANOUS ION. R.Englman.

Molecular Phys. (GB), Vol. 4, No. 2, 183-8 (March, 1961).

For Pt I, see Abstr. 20638 of 1960. The theory of optical absorption assisted by states of charge transfer is extended to intersystem (spin—change) transitions. The transition probabilities are calculated. By some very special choice of the overlap integrals agreement is obtained between the theory and the experiments on hydrated manganous ions.

14017 NEGATIVE ABSORPTION.

S.G.Rautian and I.I.Sobel'man

Optika i Spektrosk. (USSR), Vol. 10, No. 1, 134-5 (Jan., 1961).
In Russian.

Discusses conditions for "negative absorption", i.e. luminescence of higher intensity than light absorbed by excited organic molecules. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 65-6 (Jan., 1961)]. A.Tybulewicz

14018 SPECTRAL SHIFT IN ALKYL-PHENOLS.

A.K.Chandra.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 598-602 (Nov. 26, 1960).

Theoretical analysis by a simple molecular orbital-perturbation method showed that the characteristic shift in the electronic spectra of various methyl and tertiary butyl phenols could be understood in terms of hyperconjugative and inductive effects of the alkyl groups on the π-electronic energy levels of phenol.

ABSOLUTE NEGATIVE ABSORPTION IN CERTAIN MOLECULAR SPECTRA (THE "LIGHT-AVALANCHE"). See Abstr. 13173

14019 A NEW METHOD OF MODULATION OF MOLECULAR ABSORPTION IN MICROWAVE SPECTROSCOPY; STUDY OF THE J = 0→1 TRANSITION OF OCS.

A.Battaglia, A.Gozzini and E.Polacco.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 171-7 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). When gaseous carbon oxysulphide is irradiated simultaneously with waves of frequency near those of the $J = 1 \rightarrow 2$ and $J = 2 \rightarrow 3$ lines, transitions of the type $J = 1 \rightarrow 3$ occur through two-quantum absorptions. Effects on intensities and widths of absorptions due to partial saturation of one transition in such cases are considered, and the theoretical treatment (see Abstr. 5919 of 1960) is outlined. A spectrometer employing modulation of the population of the intermediate energy level through such effects is described. With detection only at the higher frequency, the frequencies of both one-quantum transitions can be sensitively detected by modulating the frequency or amplitude of the lower-frequency source. The method is applied to measure the $J = 0 \rightarrow 1$ transition of carbon oxysulphide for the first time. The sensitivity is considerably better than with simple video detection. J.Sheridan

14020 MAGNETIC HYPERFINE STRUCTURE OF THE 3, 2 LINE OF AMMONIA. K.Shimoda and K.Kondo.

J. Phys. Soc. Japan, Vol. 15, No. 6, 1125 (June, 1960).

Using a beam-type maser spectrometer, a five-component structure was observed for this case, which is exceptional in that the usually dominant quadrupole interaction of the nitrogen nucleus vanishes to a first order. A doublet splitting of the inner satellites predicted by theory was not observed. E.F.W.Seymour

14021 MICROWAVE SPECTRUM OF FORMALDEHYDE III. VIBRATION—ROTATION INTERACTION.

T.Oka and Y.Morino.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1235-42 (June, 1961).

For Pt II, see Abstr. 12286 of 1961. The centrifugal disto
constants and the inertia defects necessary for the analysis of
microwave spectrum of the formaldehyde molecule are calcula
by the vibration—rotation theory. Nielsen's formulation (Abst
2885 of 1952), is used throughout together with the useful relat
found by the present authors. The calculated centrifugal disto
constants, inertia defects and Coriolis coupling constants fit t
experimental values well.

14022 INTENSITIES AND POLARIZATIONS OF CHARAC ISTIC VIBRATIONS IN THE INFRARED ABSORPT SPECTRA OF MULTIATOMIC MOLECULES. L.A.Gribov.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 658-63 (Nov., 1960).
In Russian.

The concept of vibrations characteristic of certain chemi
groups is discussed. The intensities and polarizations of char
istic vibrational bands are dealt with. [English translation in:
Optics and Spectrosc. (USA), Vol. 9, No. 5, 346-9 (Nov., 1960)]
A.Tybu

14023 CONDITIONS FOR THE APPEARANCE OF CHARACTERISTIC POLARIZATION IN THE INFRA BANDS OF MULTIATOMIC MOLECULES. L.M.Sverdlov.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 671-3 (Nov., 1960).
In Russian.

In an earlier paper (Abstr. 20608 of 1960) the author dedu
criteria for the intensities of infrared bands to be characterist
certain chemical groups. Here it is shown that the same crite
apply to the polarization of infrared bands. [English translatio
Optics and Spectrosc. (USA), Vol. 9, No. 5, 353-5 (Nov., 1960)]
A.Tybul

14024 THE THEORY OF THE INTENSITIES OF INFRARE SPECTRA OF POLYATOMIC MOLECULES IN THE ZERO AND FIRST APPROXIMATION OF THE GENERALIZED VALENCE-OPTICAL SCHEME. L.M.Sverdlov.

Optika i Spektrosk. (USSR), Vol. 10, No. 2, 152-6 (Feb., 1961).
In Russian.

A generalized valence-optical scheme is given, which take
account of the presence of components of the dipole moment pe
pendicular to the direction of the bond. The generalized valenc
optical scheme is formulated in the zero and first approximati
As an example, a calculation of the electro—optical paramete
the sulphur dioxide molecule is carried out. [English translati
Optics and Spectrosc. (USA), Vol. 10, No. 2, 76-8 (Feb., 1961)].

14025 COMPUTATION OF PROFILES OF INFRARED AN RAMAN BANDS OF SYMMETRIC TOP MOLECULE

S.Brodersen.

J. molecular Spectrosc. (USA), Vol. 6, No. 6, 511-19 (June, 196

The general principles are discussed for the computation
the intensity distribution as a function of frequency within a
vibration—rotational band of a symmetric top molecule. Neces
and sufficient criteria are given to decide when the computatio
be stopped. These criteria will make the computation include
rotational lines with intensities above a certain lower limit. T
use of a lower limit is a necessity for the generation of a profi
similar to an observed spectrum.

14026 INFRARED AND RAMAN SPECTRA OF FLUORINA ETHANES. XVI. $CF_2Br-CCl_2Br$.

P.Klaboe and J.R.Nielsen.

J. molecular Spectrosc. (USA), Vol. 6, No. 6, 520-7 (June, 1961

For previous work see Abstr. 8839 of 1961. The infrared
absorption spectrum of gaseous $CF_2Br-CCl_2Br$ at room tempe
ture has been obtained in the region 300-3500 cm^{-1} with a Perk
Elmer double-pass spectrometer equipped with CsBr, NaCl, a
LiF prisms. In addition, the infrared spectrum of the solid wa
recorded at $+30°$ and $-170°C$, and certain spectral regions wer
studied with the sample dissolved in polar and nonpolar solvent
The Raman spectrum of the liquid at $55°C$ was photographed w
a 3-prism glass spectrograph. The compound exists as a mixt
of rotational isomers in all three states of aggregation. An att
has been made to assign fundamentals, but sufficient data could
be obtained to differentiate between the fundamentals of the two
rotational isomers.

4027 INVESTIGATION OF VIBRATIONAL FREQUENCIES OF THE SYSTEM O—H ... O IN GLYCINE SULPHATE BY RARED SPECTROSCOPY.

M.P.Bernard.

. Acad. Sci. (France), Vol. 252, No. 14, 2093-5 (April 5, 1961).
rench.

The absorption spectrum was investigated at 1800-2800 cm^{-1}.
ind at 1885 cm^{-1} was found to correspond to the valency vibration
ne of the two hydrogen bridges present in the molecule. It was
d that this band is shifted when the temperature reaches −150°C.

W.G.Jordan

4028 INFRARED SPECTRA OF SODIUM AND POTASSIUM CYANIDE.

G.E.Leroi and W.Klemperer.

hem. Phys. (USA), Vol. 35, No. 3, 774-5 (Sept., 1961).

The infrared absorption spectra of sodium cyanide and
ıssium cyanide vapours were measured in the region 3500 to
cm^{-1}. Two absorptions assigned as fundamental frequencies of
monomeric species were found in each system. The absorption
uencies and their present assignments are: NaCN $\nu_2 = 238$,
2176 cm^{-1}; KCN $\nu_2 = 207$, $\nu_3 = 2158$ cm^{-1}. A third absorption
076 cm^{-1} in sodium cyanide vapour is assigned to the dimer of
N. The bond-stretching force constant of the CN group in XCN
ecules is sensibly independent of the electronegativity of X.
angle-bending force constant varies directly with the electro-
ativity of X.

.4029 INFRARED AND RAMAN SPECTRA, FORCE CONSTANTS, AND THE STRUCTURES OF SOME POLY- IDE IONS: ICl_2^-, ICl_4^-, $BrCl_2^-$, AND Br_3^-.

3.Person, G.R.Anderson, J.N.Fordemwalt, H.Stammreich and
'orneris.

hem. Phys. (USA), Vol. 35, No. 3, 908-14 (Sept., 1961).

The infrared and Raman spectra for these polyhalide ions are
sented. From these data, the X—Y stretching force constant f_r,
interaction force constants f_{rr} between bond stretching coordi-
es at 180° to each other, and the interaction force constant f'_{rr}
bond stretching coordinates at an angle of 90° (for ICl_4^-) are cal-
ated. The values of f_r for the trihalide ions are roughly one-half
values for the free halogens, and the values of the interaction
ce constants f_{rr} are very large (approximately 35% the value of
stretching constant f_r). These rather unusual force constants
interpreted in terms of the description of the bonding in these
s using p orbitals, which was first suggested by Pimentel. In
t, these results offer rather strong support for the recent
dence from nuclear quadrupole coupling constant measurements
Cornwell and Yamasaki favouring this structure. Attention is
ıwn to the qualitative similarity between these force constants
those for the HF_2^- ion.

14030 THEORY AND MEASUREMENT OF PRESSURE-INDUCED SHIFTS OF HCl LINES DUE TO NOBLE SES.

A.Ben-Reuven, S.Kimel, M.A.Hirshfeld and J.H.Jaffe.

hem. Phys. (USA), Vol. 35, No. 3, 955-62 (Sept., 1961).

Pressure shifts of HCl absorption lines in both the 1-0 and 2-0
ıds caused by five noble gases were measured. An outstanding
ture of these measurements is that the shifts are not the same
all lines of a band, but there is a strong dependence on the
ational quantum number J. However, there is evidence that the
fts tend to a constant limit for high J numbers. In order to
erpret these results induction- and dispersion-type van der Waals
ces are considered and used in conjunction with existing line-
ıpe theories. In cases where perturbation theory can be applied,
limit shifts are accounted for fairly well, although no satis-
tory explanation has emerged for the J dependence. Attention is
ıwn to the significance of observations of this sort as a means of
aining information about intermolecular forces and molecular
ıstants. Of particular interest is the possibility of obtaining such
ormation for molecules in specific quantum states.

14031 THE EFFECT OF AN AGGREGATE STATE ON THE INTENSITY AND STRUCTURE OF CERTAIN SORPTION BANDS OF CARBON TETRACHLORIDE IN THE ESENCE OF FERMI RESONANCE.

P.Lȳsȳtsya and V.M.Malȳnko.

rayin fiz. Zh. (USSR), Vol. 3, No. 4, 482-7 (1958). In Ukrainian.

The 6 i.r. bands investigated form three doublets, the com-
nents of which undergo Fermi interaction. During the liquid—
pour change of state, the intensity of the long-wave component
each doublet is considerably decreased, which indicates a weakening of the resonance interaction between the respective vibrating levels. Besides the decrease in intensity, there is an isotopic splitting of these components into several (from 2 to 5) constituents. Except for the basic vibration ν_3, the half-width of the remaining bands change little on passing from the liquid to the vapour state.

PRECISE INFRARED WAVELENGTHS OF HCN, N_2O AND CO MOLECULES. See Abstr. 12985

14032 INTENSITY STUDIES IN RAMAN EFFECT: EFFECT OF CONJUGATION.

K.Venkateswarlu and K.Ramaswamy.

Proc. Indian Acad. Sci. A, Vol. 51, No. 3, 146-50 (March, 1960).

The changes in frequency and the intensities of various unconjugated and conjugated substances in different solvents were investigated. It is found that there is an increase in C=O frequency in nonpolar solvents. The intensity of the C=O line shows, in general, considerable diminution in nonpolar solvents. The C=C, C—H_{arom} and C—C vibrations also behave in the same way.

14033 INTENSITY OF RAMAN LINES IN CARBOXYLIC ACIDS, ESTERS AND NITRILES.

K.Venkateswarlu and C.Balasubrâmanian.

Proc. Indian Acad. Sci. A, Vol 51, No. 3, 151-4 (March, 1960).

In both carboxylic acids and esters the intensities of Raman lines due to C=O, C—H bending and C—H_{aliph} stretching vibrations are found to increase from lower to higher members of the series while there is a decrease in intensity of C—C frequency. The intensity of the lines due to C≡N vibration is found to be decreasing from lower to higher members of the series. The intensity in aromatic conjugated nitrile is found to be abnormally great when compared to that in unconjugated aliphatic nitriles.

14034 RAMAN SPECTRA OF FLUOROBENZENE AT DIFFERENT LOW TEMPERATURES.

D.K.Mukherjee.

Indian J. Phys., Vol. 34, No. 9, 402-6 (Sept., 1960).

The Raman spectra in the solid state at −60°C and −180°C were investigated and compared with the spectrum due to the liquid. At −60°C the crystals produce a new low-frequency line at 95 cm^{-1} and the line shifts to 100 cm^{-1} when the temperature is lowered to −180°C. This new line is attributed to the formation of dimers at low temperature. Further, the Raman shifts of some prominent lines were observed to change with solidification of the compound and lowering of temperature and these changes are also attributed to the formation of dimers. The polarization of the Raman lines was reinvestigated and it was observed that the line 517 cm^{-1} is not totally depolarized, and although the value of the factor of depolarization is quite large it is actually less than $\frac{6}{7}$.

14035 RAMAN, INFRARED AND LUMINESCENCE SPECTRA OF SOME TRISUBSTITUTED BENZENES.

K.K.Deb and S.B.Banerjee.

Indian J. Phys., Vol. 34, No. 12, 554-64 (Dec., 1960).

Tentative assignments of the vibrational frequencies of the molecules of 2,4- and 3,4-dichlorotoluene and 1,2,4-trichlorobenzene are proposed from an analysis of the Raman and infrared spectra. The Raman spectra of the dichlorotoluenes were investigated at −180°C and it was observed that some of the intramolecular vibrations are affected and a few low-frequency lines are exhibited by the compounds at this low temperature. Explanation of these changes is offered in terms of association of the molecules. It was also observed that in the solid state at −180°C both the compounds yield luminescence bands and the C=C valence oscillation appears to be coupled with the electronic transition giving rise to these bands.

14036 THE RAMAN SPECTRA OF COPPER CYANIDE AND SILVER CYANIDE ANIONS.

R.Gaufrès.

C.R. Acad. Sci. (France), Vol. 252, No. 21, 3227-9 (May 24, 1961).
In French.

Frequencies in the region 2100 cm^{-1} are given for $Ag(CN)_3^{2-}$, $Ag(CN_4^{3-})$, $Cu(CN)_2^-$ and $Cu(CN)_3^{2-}$. The frequencies and intensities indicate that Cu is more electronegative than silver.

G.F.Lothian

14037 RADIOFREQUENCY DISCHARGE THROUGH OXYGEN.

L.Herman, R.Herman and D.Rakotoarijimy.

J. Phys. Radium (France), Vol. 22, No. 1, 1-8 (Jan., 1961).
In French.

Using flowing oxygen at atmospheric pressure, it was possible, with high dispersion spectrographs, to extend the vibrational and rotational analysis of the Schumann-Runge bands (B $^3\Sigma$–X $^3\Sigma$ system) up to 5 700 A. Predissociation is shown at ν' = 3 and 4. The level ν' = 4 is strongly predissociated, but there is no predissociation at ν' = 5. In the same discharge, some new atmospheric bands are observed. Each of the $\Delta\nu = +1$ and $\Delta\nu = 0$ sequences have five bands. It is suggested that the excitation of the atmospheric bands is due to an interaction between the X $^3\Sigma$ and b $^1\Sigma$ states; it is enhanced by the high pressure of the gas.

14038 THE MAGNETIC ROTATION SPECTRUM OF SINGLET—TRIPLET TRANSITIONS.

W.H.Eberhardt and H.Renner.
J. molecular Spectrosc. (USA), Vol. 6, No. 5, 483-91 (May, 1961).

Magnetic rotation spectra have been found corresponding to the singlet—triplet transitions in formaldehyde, glyoxal, and benzoquinone. The spectrum in formaldehyde is very similar to the absorption spectrum; that in glyoxal is especially intense and exhibits some unusual peculiarities in both vibrational and rotational structure. Benzoquinone exhibits a magnetic rotation spectrum in only a single band which may be the origin of the singlet—triplet transition. No magnetic rotation spectrum was found for transitions reported to be of this type in several other substances.

14039 EMISSION SPECTRUM OF BISMUTH MONOCHLORIDE. I. THE VIBRATIONAL ANALYSIS OF THE 6170-4220 A SYSTEM.

P.Venkateswarlu and B.N.Khanna.
Proc. Indian Acad. Sci. A, Vol. 51, No. 1, 14-27 (Jan., 1960).

Bismuth chloride was excited in flowing condition with an uncondensed transformer discharge. About 390 bands were observed, of which only 140 have been recorded by earlier workers. The vibrational constants obtained are the same as those obtained by Morgan (1936) from absorption experiments except for the addition of a cubic term for the upper state. It appears quite likely that the upper state of the system dissociates into Bi ($^4S_{3/2}$) + Cl ($^2P_{1/2}$) while the lower state, which is probably the ground state, dissociates into Bi ($^4S_{3/2}$) + Cl ($^2P_{3/2}$). Estimates of the dissociation energies obtained by extrapolations are $D_0' = 3750$ cm^{-1} and $D_0'' = 24614$ cm^{-1}.

14040 THE BAND SPECTRUM OF A CuAg MOLECULE IN THE VISIBLE REGION.

K.C.Joshi and K.Majumdar.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 197-200 (Aug., 1961).

The emission spectrum of a CuAg molecule in the visible region was investigated in thermal emission at 1800°C in a vacuum graphite furnace. Bands were observed in the region λλ4090-3790. All these bands are degraded to red and were classified in one band system ascribed as A–X. The bands can be represented by the equation

$$\nu_{v'v''} = 25\,851{\cdot}6 + 178{\cdot}5(v' + \tfrac{1}{2}) - 0{\cdot}50(v' + \tfrac{1}{2})^2 - 231{\cdot}8(v'' + \tfrac{1}{2}) + 0.80(v'' + \tfrac{1}{2})^2.$$

14041 BAND SPECTRUM OF THE GaH MOLECULE.

M.L.Ginter and K.K.Innes.
J. molecular Spectrosc. (USA), Vol. 7, No. 1, 64-80 (July, 1961).

An extensive emission system of GaH, in the region 5200-6400 A, was obtained from a King furnace containing gallium metal and hydrogen at 1500° C. Fourteen bands were measured and analysed on the assumption, previously made by Neuhaus, that they arise from a $^2\Pi_{1,0}$–$X^1\Sigma^+$ transition. The following constants were determined (cm^{-1}):

	T_e	ω_e	$x\omega_e$	$y\omega_e$	B_e	α_e	γ_e	D_ex10^4
$^3\Pi_1{}^+$	17622.01	1631.17	58.22	−7.47	6.692	0.326	−0.0315	4.89
$^3\Pi_0{}^+$	17337.08	1640.54	62.72	−6.195	6.394	0.276	−0.0400	2.62
$X^1\Sigma^+$	0	1604.52	28.77	+0.360	6.137	0.181	−0.0005	3.37

A relatively weak fifteenth band was analysed as the 0—0 band of the transition $^3\Pi_2$—$^1\Sigma^+$. Its band centre and rotational constants are just those one would expect if each of the above constants, a_Ω, obeys the equation $a_2 - a_1 = a_1 - a_0$. Diffuse features corresponding to transitions from an unstable state to the lowest three vibrational levels of the ground state were observed between 4200 and 4850 A.

14042 A SPECTROPHOTOMETRIC ATLAS OF THE SPECTRUM OF CH FROM 3000 A to 5000 A.

A.M.Bass and H.P.Broida.
Nat. Bur. Stand. (USA), Monogr. No. 24, 20 pp. (1961).

The spectrum was recorded photoelectrically from an acetylene—oxygen flame in the region 4900 to 3000 A by use of a high-resolution grating monochromator. Each of the lines in the CH spectrum is identified.

14043 INFLUENCE OF TEMPERATURE ON THE RAMA SPECTRUM OF GLYCERIN.

R.Ebenstein and M.Harrand.
J. Phys. Radium (France), Vol. 22, No. 6, 353-5 (June, 1961).
In French.

No shift of frequencies is observed when the temperature increased from 25° to 170° C, but there is a decrease in width two bands at 1465 cm^{-1} and at 1066-1105 cm^{-1} (respectively and 6%), which is the result of depolymerization.

14044 EMISSION SPECTRA FROM GLOW DISCHARGE THROUGH VAPORS OF AROMATIC HYDROCARB AND n-HEXANE.

M.Nishi, S.Hamamura and H.Araki.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1536 (Aug., 1960).

Many aromatics show four regions of emission, designate A, B, C and D. A is due to π-electron transitions in the benze ring, and D to benzyl radicals. Because of variation of intens with pressure and with nature of the aromatic, Schuler's assigments of the B and C continua to C_6H_5CH and C_6H_5C radicals i doubted. A.G.

14045 A STUDY OF THE CN EMISSION FROM ACTIVE NITROGEN FLAMES.

K.D.Bayes.
Canad. J. Chem., Vol. 39, No. 5, 1074-85 (May, 1961).

When organic compounds are added to active nitrogen, the and violet bands of the CN radical are emitted. The relative i sities of these red bands were measured for a variety of adde pounds, temperatures, and pressures. It is shown that there a least three processes producing electronically excited CN radi two yielding CN($A^2\Pi$) and one yielding CN($B^2\Sigma$). The behaviour the flames indicates that a chain mechanism is involved. Addi ammonia, which does not react with nitrogen atoms, quenches CN emission and inhibits the consumption of nitrogen atoms. is concluded that a second reactive species in active nitrogen, possibly metastable $N_2(A^3\Sigma)$ molecules, initiates the reactions which result in light emission.

EMISSION SPECTRA OF FLAMES SUPPORTED BY ACTI NITROGEN. See Abstr. 13942-3

SPECTRA INDUCED BY PROTON IMPACT ON NITROGE See Abstr. 13944

14046 EFFECT OF PRESSURE ON THE EXCITATION FUNCTIONS OF CERTAIN BANDS OF A NEGATIV SYSTEM OF THE N_2^+ MOLECULE.

S.M.Kӯshko and M.Yu.Kuchӯnka.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 384-8 (1959). In Ukraí

The conditions were studied under which excitation functio are obtained for various $B^2\Sigma \rightarrow X^2\Sigma$ transformation bands. It w established that excitation functions for the (0 → 0) - and (0 → 1 bands of a negative N_2^+ system, the limits of which lie at 3914 and 4278 A respectively, are obtained with nitrogen pressures below 4.5 × 10^{-3} mm Hg and with a current density of the excit electrons less than 1.3 × 10^{-3} A/cm^2. Comparing the results c measurements with the experimental conditions of previous inv gators, it is easy to see that the exciting electrons undergo numerous collisions in the excitation tubes as a result of high nitrogen pressures or high electron current densities. That is optical excitation functions with various errors were obtained previous researches of the 1930's.

14047 ELECTRONIC SPECTRA OF DIMERS. I. NATURE THE COUPLING.

A.Witkowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), No. 3, 179-83 (1961).

It is shown that for a dimer composed of two diatomic chro phores the asymmetric stretching mode may couple strongly w the electronic motions in the excited state. T.E.Pe

14048 ELECTRONIC SPECTRA OF DIMERS. II. PERTU TION SOLUTIONS OF THE FUNDAMENTAL VIBRO EQUATION.

A.Witkowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), No. 3, 185-7 (1961).

The reduced Hamiltonian η describing vibronic states of t dimer (see preceding abstract) is

$$\eta = \tfrac{1}{2}(p^2 + q^2) + bq\sigma_3 + c\sigma,$$

where q and p are the space and momentum coordinates of th metric stretching mode, b is the change in equilibrium ions of the nuclei in the ground and excited states, c is a meas- f the resonance coupling between the two molecules forming the r, and σ_1 and σ_3 are the usual Pauli matrices. The strong ing ($b^2 \ll |c|$) and the weak coupling ($c\sigma_1$ small) problems are dered and solved using perturbation theory. T.E.Peacock

4049 ELECTRONIC SPECTRA OF DIMERS. III. INTENSITIES. A.Witkowski.

Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, , 189-91 (1961).

t is shown that the resonance coupling parameter c (see pre- g abstract) is the dominant effect responsible for the change in of the spectra of dimers as compared with that of the mer. T.E.Peacock

4050 THE λ2763 A (0,9) BAND OF THE O_2 SCHUMANN—RUNGE SYSTEM. G.R.Hébert and R.W.Nicholls.

mos. terrest. Phys. (GB), Vol. 21, No. 2-3, 213-15 (June, 1961).

4051 ULTRAVIOLET BAND SPECTRA OF AsO AND AsO^+. S.V.J.Lakshman and P.Tiruvenganna Rao.

n J. Phys., Vol. 34, No. 6, 278-88 (June, 1960).

The band spectrum of AsO was excited, in a heavy-current arge from a 4kV transformer, using a quartz discharge tube internal hollow nickel electrodes fed with a specpure sample s_2O_3. Two new doublet systems of bands designated as Π and D-$X^2\Pi$, analogous to those reported by one of the authors shman, 1960) in the case of SbO, were observed in the region 0 - λ 2400 A. Vibrational analyses of these systems were ied out leading to the following quantum formulae:

$$X^2\Pi:\ \nu = \left.\begin{matrix}38637.1\\37664.8\end{matrix}\right\} +656.3(\nu'+\tfrac{1}{2})-4.85(\nu'+\tfrac{1}{2})^2-964.0(\nu''+\tfrac{1}{2})+4.50(\nu''+\tfrac{1}{2})^2$$

$$X^2\Pi:\ \nu = \left.\begin{matrix}38805.9\\37780.5\end{matrix}\right\} +611.5(\nu'+\tfrac{1}{2})-3.338(\nu'+\tfrac{1}{2})^2-964.0(\nu''+\tfrac{1}{2})+4.50(v''+\tfrac{1}{2})^2$$

ldition to the above systems, a singlet system of bands was ined in the region λ 2550 - λ 2200 A. A vibrational analysis of system gave the following constants: $\nu_e = 42601.1\ cm^{-1}$, $777.0\ cm^{-1}$, $\omega_e' = 1100.4\ cm^{-1}$, $x_e' \omega_e' = 6.57\ cm^{-1}$, $e'' = 4.878\ cm^{-1}$. From the magnitude of the vibrational tants, it is concluded that the emitter of this system is the rto unknown AsO^+ ion. Detailed arguments are presented for gning this system to AsO^+. The observed electronic states of and AsO^+ are compared and discussed with those of the ted molecules on the basis of MO electron configurations.

14052 ON THE ${}^3E_{1u}-{}^1A_{1g}$ INTERCOMBINATION IN BENZENE. E.Clementi.

olecular Spectrosc. (USA), Vol. 6, No. 5, 497-508 (May, 1961).

The lifetime and the oscillator strength for the ${}^3E_{1u}-{}^1A_{1g}$ rcombination has been calculated. The perturbing singlets for ${}^3E_{1u}$ state are the ${}^1E_{1u}$ (π,π^*) and two ${}^1A_{2u}$ (σ,π^*). One of the perturbing singlet is obtained by promotion of one electron n a σ bonding molecular orbital of the carbon-carbon bonds, the r ${}^1A_{2u}$ perturbing singlet is obtained by promotion of one tron from a σ bonding molecular orbital of the carbon—hydrogen ds. The one-electron part and the two-electron part of the spin ital Hamiltonian are both considered in the calculation. The tric field acting on the electrons is obtained following the roximation introduced by Hameka (1956). The two centre integrals e computed in the cases where the one centre integrals are ishing and are otherwise neglected. The results of the calcula- show that the ${}^3E_{1u}$ transition has an f value of $\sim 2 \times 10^{-10}$ and time $\tau \cong 20$ seconds; consequently the ${}^3E_{1u}$ transition is too k to be identified with the system of weak bands observed in id benzene spectra and crystal benzene spectra in the 2600 A ion. The oscillator strength of the ${}^1A_{2u}-{}^1A_{1g}$ transitions is esti- ted to be in the range $f = 2-5 \times 10^{-2}$ the more definite value ending on the still unknown location of the ${}^1A_{2u}$ perturbing states.

14053 SINGLET→TRIPLET ABSORPTION IN HALOGEN SUBSTITUTED TOLUENES. J.K.Roy.

an J. Phys., Vol. 34, No. 7, 331-5 (July, 1960).

Continuous singlet→triplet absorption in the near ultraviolet to o-bromotoluene, p-chlorotoluene and m-fluorotoluene in the id state was investigated. It was observed that the region of orption shifts gradually towards the red with the increase in the nic weight of the substituent halogen atom. The luminescence ctrum due to m-fluorotoluene in the solid state at −180° C was also studied, and the luminescence bands were found to be weaker than those due to chloro- and bromotoluene.

14054 ON THE SINGLET → TRIPLET ABSORPTION IN AROMATIC COMPOUNDS IN GASEOUS STATE.

S.C.Sirkar and J.K.Roy.

Indian J. Phys., Vol. 34, No. 12, 581-3 (Dec., 1960).

The absorption spectra in the near ultraviolet region of benzene and o-bromotoluene in the vapour state at the respective saturation pressures at room temperature were photographed with a path length of about 62 ft and compared with the spectra due to the substances in the liquid state having equivalent path lengths. It was observed that although benzene in the liquid state with a path length 1.2 cm shows considerable absorption in the 3300-3400 A region due to singlet → triplet transition, such absorption in the case of the vapour at 12 mm pressure, with a path length of 62 ft, is very much less than that in the liquid. Similar results were observed with o-bromotoluene, the path length being 7 mm for the liquid and 62 ft for the vapour at 55 mm pressure. It is pointed out that the singlet → triplet absorption and the corresponding luminescence observed by previous workers in these compounds are enhanced considerably in the state of aggregation of the molecules.

14055 CORRELATIONS BETWEEN THE ELECTRONIC SPECTRA OF ALTERNANT HYDROCARBON MOLECULES AND THEIR MONO- AND DI-VALENT IONS. II. HYDROCARBONS WITH SYMMETRY D_{2h}.

G.J.Hoijtink, N.H.Velthorst and P.J.Zandstra.

Molecular Phys. (GB), Vol. 3, No. 5, 533-46 (Nov., 1960).

For Pt I, see Abstr. 20648 of 1960. On the basis of a qualitative quantum mechanical theory of the energies and dipole strengths of the lower π-electronic transitions in alternant hydrocarbon molecules and their mono- and di-valent ions a comparison is made between the spectra in the 5-45 kK region of the molecules and ions of naphthalene, anthracene, tetracene, pyrene and perylene.

14056 THE NEAR ULTRAVIOLET ABSORPTION SPECTRA OF TOLAN. O.P.Kharÿtonova.

Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 729-33 (1959). In Ukrainian.

The absorption spectrum of tolan vapours and solutions was investigated at 77° K. The luminescence spectrum of a tolan solution in ethyl alcohol was studied at −170° C. The oscillator strengths in spectra of vapours and solutions were determined for electronic transitions of tolan vapours and solutions in ethyl alcohol at 77° K were compared with the a-component of the tolan monocrystal at 20° K. For this purpose the spectrum of the solution was displaced in the ultraviolet by 1680 cm^{-1} and the spectrum of the crystal by 2520 cm^{-1}.

14057 ESTIMATION OF (Δr_e) OF AN ELECTRONIC BAND SYSTEM — A NEW METHOD.

N.R.Tawde and A.P.Walvekar.

Indian J. Phys., Vol. 34, No. 9, 397-40 (Sept., 1960).

A new method is suggested of constructing the Morse potentials associated with an electronic band system without the knowledge of internuclear distances, and thus estimating the difference (Δr_e) in the equilibrium distances in the two states. A knowledge of Δr_e is an essential parameter in the theories of vibrational transition probabilities in molecular spectra.

14058 ON THE ELECTRONIC STRUCTURE OF HeH^+. R.Bhattacharya.

Proc. Nat. Inst. Sci. India A, Vol. 27, No. 3, 185-92 (May, 1961).

A theoretical calculation of the electronic energy of HeH^+ by a quantum mechanical method at various internuclear distances shows that the equilibrium internuclear separation appears at 1.75 a.u. as compared to the value of 1.50 a.u. reported by Duncanson and Coulson (1938). The electronic charge was concentrated wholly on He nucleus in the bonding state giving to HeH^+ a structure He^-H^+. From the convergence of bonding and antibonding energy curves it is concluded that HeH^+ dissociates as He^+ and H.

14059 ELECTRONIC TRANSITION MOMENT VARIATION IN ($B^1\Sigma \rightarrow X^1\Sigma$) BANDS OF BeO.

N.R.Tawde and N.S.Murthy.

Proc. Indian Acad. Sci. A, Vol. 51, No. 4, 219-31 (April, 1960).

Accurate integrated intensity data of the bands of the BeO ($B^1\Sigma \rightarrow X^1\Sigma$) system were obtained by photographic photometry. With the use of Franck—Condon factors and r-centroids for the bands, available from the literature, the relation of electronic transition moment R_e to internuclear separation r is evolved. The vibrational transition probabilities are corrected for the resulting variation of R_e with r. These corrected values are examined in relation to those under assumptions of constancy of R_e in conjunction with (1) mechanical anharmonicity and also (2) mechanical harmonicity.

14060 EXPERIMENTAL STUDY OF TRANSITION PROBABILITIES IN ASTRAL RADICALS:LaO(B → X) SYSTEM.

N.R.Tawde and P.V.Chandratreya.

Current Sci. (India), Vol. 30, No. 4, 137 (April, 1961).

Band head intensities, measured by photographic photometry, of the (0-0,1,2); (1-0,1,2,3); (2-0,1,2,3,4); (3-1,2,3,4); (4-2,3,4) bands of the LaO ($B^2\Sigma$-$X^2\Sigma$) yellow system are interpreted in terms of relative vibrational transition probabilities. R.W.Nicholls

14061 ERRATUM: ELECTRONIC STRUCTURE OF NITRIC OXIDE.

H.Brion, C.Moser and M.Yamazaki.

J. chem. Phys. (USA), Vol. 33, No. 6, 1871 (Dec., 1960).

See Abstr. 7440 of 1959.

14062 EXCITED STATES OF ACETYLENE.

W.Woźnicki.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 273-9 (1961).

A 10-electron calculation using the ASMO method is reported. The 1s electrons on the carbon atoms are not included. The calculations are carried through assuming an sp carbon valence state and for states with increasing p character up to sp_2. It is found that the linear state (sp hybrids) forms the most stable ground state whilst the most stable form for the first excited (electronic) state is that formed from carbon atoms in a pure sp_2 hybrid state. T.E.Peacock

14063 ON THE VARIATION OF ELECTRONIC TRANSITION MOMENT R_e IN CN VIOLET BAND SYSTEMS.

S.S.Prasad.

Indian J. Phys., Vol. 34, No. 12, 584-5 (Dec., 1960).

The experimental data of King and Floyd (see Abstr. 4514 of 1955) are used to calculate R_e as a function of the atomic separation r. R_e is found to vary only slowly with r, which agrees with the suggestion of Bates (see Abstr. 2839 of 1949) for a $\Sigma - \Sigma$ transition. G.F.Lothian

14064 THE ELECTRONIC STRUCTURE AND SPECTRUM OF NITROBENZENE.

T.E.Peacock.

Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 460-3 (Sept., 1961).

The self-consistent-field molecular orbital theory is used to calculate the π electronic structure and spectrum.

14065 THE EFFECT OF VIBRATIONS ON THE FORBIDDEN TRANSITIONS IN A MOLECULE.

A.M.Meleshina.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 564-70 (Nov., 1960). In Russian.

Gives a calculation of the oscillator strength of the forbidden band of benzene at 2600 A, due to E_g^+ vibrations. Wave-functions were determined by solving Schrödinger's equation, using the Bogolyubov parameter; good agreement with experiment was obtained. [English translation in: Optics and Spectrosc (USA), Vol. 9, No. 5, 299-302 (Nov., 1960)]. A.Tybulewicz

14066 COMPLETE SET EXPANSIONS FOR MOLECULAR WAVE FUNCTIONS.

H.O.Pritchard and F.H.Sumner.

J. phys. Chem. (USA), Vol. 65, No. 4, 641-5 (April, 1961).

The wave-function for the $1s\sigma_g$, $2s\sigma_g$ and $3d\sigma_g$ states of H_2^+ were expanded in terms of two complete sets of spherical functions, one centred on each atom. No serious difficulty was caused by overcompleteness, and excellent representations of the energies and wave-functions were obtained.

14067 PROPERTIES OF THE SELF-CONSISTENT FIELD TREATMENT OF CONJUGATED MOLECULES.

H.H.Greenwood and T.H.J.Hayward.

Molecular Phys. (GB), Vol. 3, No. 5, 495-509 (Sept., 1960).

The polarizability properties of π electron systems are treated by the self-consistent field method, as modified by Pople for application to conjugated molecules. An analytical treatment of the π electron configuration of substituted hydrocarbons deduces certain universal symmetry properties of this method, and contains the Hückel treatment of inductive substituents as a simplified special case. Whereas the usual Hückel theory derives results by approximate perturbation methods, the treatment given here is forma exact. In a later section s.c.f. polarizability coefficients, as lated on an Elliott-402 digital computer, are given for benzen naphthalene, anthracene and phenanthrene, and the prediction chemical properties are shown to be in better agreement with ment than predictions derived from Hückel theory.

14068 MOLECULAR TWO-CENTRE HYBRID AND EXCH INTEGRALS BETWEEN 2pπ AND 3pπ ATOMIC ORBITALS.

A.Lofthus.

Molecular Phys. (GB), Vol. 4, No. 1, 17-24 (Jan., 1961).

All possible two-centre hybrid and exchange integrals bet 2pπ and 3pπ atomic orbitals with equal orbital exponent α are calculated and tabulated for $\alpha = 1.00\,(0.25)\,9.00$.

14069 MOLECULAR TWO-CENTRE INTEGRALS BETW 2pπ AND 3pπ ATOMIC ORBITALS. II. COULOMB INTEGRALS.

A.Lofthus.

Molecular Phys. (GB), Vol. 4, No. 2, 177-81 (March, 1961).

All possible two-centre Coulomb integrals between 2pπ a atomic orbitals with equal orbital exponent α have been evalua analytically and are tabulated for $\alpha = 1.00\,(0.25)\,10.00$.

14070 LEAST-SQUARES LOCAL-ENERGY METHOD FO MOLECULAR ENERGY CALCULATIONS USING G QUADRATURE POINTS.

A.A.Frost, R.E.Kellogg, B.M.Gimarc and J.D.Scargle.

J. chem. Phys. (USA), Vol. 35, No. 3, 827-31 (Sept., 1961).

The least-squares local-energy method previously descri and tested in calculations on H_2^+ (Abstr. 17829 of 1960) is furt tested on H_2^+, He, and H_2. The theory of Gauss quadrature is to provide a better basis of points over which to average the l energy. The electronic energy is easily calculated to six sign figures for H_2^+ and to three or four significant figures for He

14071 ELECTRONS AND HOLES IN ALTERNANT HYDR CARBONS.

A.D.McLachlan.

Molecular Phys. (GB), Vol. 4, No. 1, 49-56 (Jan., 1961).

This paper uses the theory of creation and destruction op to give a new simpler proof of the well-known pairing relation between electronic states of alternant hydrocarbon positive an negative ions. The method is like one that Heisenberg used to explain why the atomic spectra of elements such as C (with tw electrons in the 2p shell), and O (with two holes) are so simila It depends on the analogy between electrons in an orbital ψ' an in the paired antibonding orbital ψ' of the π-electron shell. A modified pairing relation holds also in a magnetic field. Applications of the operators to other problems are suggested.

14072 THE VARIATIONAL CALCULATION OF MOLECU PROPERTIES.

F.Dupont-Bourdelet, J.Tillieu and J.Guy.

J. Phys. Radium (France), Vol. 22, No. 1, 9-18 (Jan., 1961). In French.

In particular for electric and magnetic properties, a gene formalism is set up to take account of several simultaneous pe turbations. Energies are explicitly calculated up to the fourth and it is shown that the formulae only contain the perturbed fu tions of the first and second orders. By means of certain hypo the equations and matrix terms can be separated (often linearl either to different perturbing operators or to independent grou particles (e.g. electrons and nuclei).

14073 THE DIAMAGNETIC SUSCEPTIBILITIES OF SOME HYDROGEN-BONDED MOLECULES.

R.Mason.

Molecular Phys. (GB), Vol. 4, No. 2, 191-2 (March, 1961).

A measure of delocalization can be obtained by considerin difference between the out-of-plane susceptibility and the total atomic susceptibilities; this is applied to succinic acid, succin oxalic acid dihydrate and maleic acid, and delocalization is fou be much more important for the latter two molecules, which fo shorter H bonds. J.Ha

14074 THE DIAMAGNETIC SUSCEPTIBILITY OF ETHYI AND ACETYLENIC HYDROCARBONS.

P.Pascal, F.Gallais and J.F.Labarre,

C.R. Acad. Sci. (France), Vol. 252, No. 18, 2644-9 (May 3, 196 In French.

Molar susceptibility values for eleven linear alkanes, eigh linear alkenes, and four linear alkynes are tabulated. Susceptib

es are deduced for the various radicals and bonds involved and ɔared with values calculated from semi-empirical data.
G.I.W.Llewelyn

1075 EXPERIMENTAL STUDY OF REFRACTIVITIES.

H.Fousse and J.Grange.

ers de Phys. (France), Vol. 15, 56 (Jan., 1961). In French.

Values for a series of covalent bond refractivities are tabulat- Organic group refractivities calculated from these values in good agreement with experimental results. G.I.W.Llewelyn

4076 EXPERIMENTAL STUDIES OF REFRACTIVITIES. BOND REFRACTIVITIES.

J.Grange and H.Fousse.

iers de Phys. (France), Vol. 15, 183-8 (April, 1961). In French.

Some values are proposed for the refractivities of the , C=C, C≡C bonds. Their validity is tested by application to many s of hydrocarbon: saturated, ethylenic, aromatic, acetylenic cyclic. The agreement between theory and experiment is very sfactory. T.E.Peacock

4077 THE O—H...O BOND IN ORTHOBORIC ACID.

J.A.Ibers and C.H.Holm.

hys. Soc. Japan, Vol. 16, No. 4, 839 (April, 1961).

In a previous calculation (Kume and Kakiuchi, Abstr. 9074 of) it was shown from p.m.r. data, that the O—H...O bond was non- ar in contradiction to the X-ray data on the dimer. It is pointed here that these authors omitted the contribution to the second nent of the boron—hydrogen interactions. It is shown that when e are included, the p.m.r. results are compatible, with the ay data and predict a linear O—H..O bond. See also following ract. T.E.Peacock

4078 THE O—H..O BOND IN ORTHOBORIC ACID.

K.Kume and Y.Kakiuchi.

hys. Soc. Japan, Vol. 16, No. 4, 843-4 (April, 1961).

Using the results of Ibers and Holm (see preceding abstract) relationship between second moment and BOH angle was alculated. The best fit between the bond angle and the second nent occurs for an angle of 105° ± 4.6° instead of 90°, as orted previously. T.E.Peacock

4079 MAGNETIC STUDY OF THE LOCALIZED CHEMICAL BOND.

J.Baudet.

him.phys. (France), Vol. 58, No. 2, 228-45 (Feb., 1961). rench.

The application of the variation method to the calculation of ecular diamagnetic susceptibilities allows a theoretical magneto- mical series to be set up. The various results obtained by cal, Pacault and their collaborators have been collected into a series by Pascal, Pacault and Hoarau. The results obtained application of the two series are in excellent agreement with the erimental results. A theoretical and experimental study was de of various aromatic and heterocyclic molecules, it shows the antages of the theoretical over the experimental classification it permits the interpretation of the errors in the latter. The ceptibilities of the iodine and sulphur molecules are calculated are in agreement with the experimental values. This confirms value of the variation method for the determination of the gnetic susceptibilities of localized bonds. T.E.Peacock

14080 ON A MODIFICATION OF THE FEMO METHOD IN THE CASE OF BENZOPHENONE.

E.Jużków.

ll. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, . 11-12. 799-801 (1960).

By taking account of the nonequivalence of the bonds between the ms, a certain measure of improvement is found in the evaluation the wave numbers and oscillator strength. R.A.Ballinger

14081 NUCLEAR RESONANCE STUDIES OF HYDROGEN BONDING IN ALCOHOLS. I. DILUTION SHIFT STUDIES.

M.Connor and C.Reid.

molecular Spectrosc. (USA), Vol. 7, No. 1, 32-45 (July, 1961).

The concentration dependence of the OH proton chemical shifts a variety of alcohols in solution in carbon tetrachloride were died by nuclear resonance. The forms of the dilution shift curves ained and the values of the association shifts are discussed in ation to the expected extents of hydrogen bonding in such solutions. imited correlation between the association shifts and the integ- ed intensities of the OH stretching vibrations of the alcohols died was found.

14082 SOME INVESTIGATIONS IN THE THEORY OF OPEN-SHELL IONS. II. V, W AND X COEFFICIENTS.

J.S.Griffith.

Molecular Phys. (GB), Vol. 3, No. 3, 285-97 (May, 1960).

For Pt I, see Abstr. 20864 of 1960. V, W, and X coefficients analogous to Racah's $\bar{V}$, $\bar{W}$ and $\bar{X}$ coefficients and Wigner's 3j, 6j and 9j symbols are defined for certain finite groups and their properties examined. Tables of values of these coefficients are given for the one-valued representations of the octahedral group.

14083 SOME INVESTIGATIONS IN THE THEORY OF OPEN-SHELL IONS. III. THE CALCULATION OF MATRIX ELEMENTS.

J.S.Griffith.

Molecular Phys. (GB), Vol. 3, No. 5, 457-75 (Sept., 1960).

The use of V, W and X coefficients in calculations of matrix elements is shown. General formulae for all two-electron spin-orbit coupling matrices in an octahedral strong-field coupling scheme are deduced. The parametrization of the electrostatic energy in ligand field theory is discussed and the number of parameters required is given in various cases. The configuration f^2 in an octahedral strong-field scheme is treated in some detail and reasons for the anomalously low paramagnetism of PuF_6 are exposed, largely in contradiction to earlier views. Finally it is shown that expressions involving recoupling matrix elements, which occur in a scheme for calculating matrix elements of one-electron operators given by Tanabe and Kamimura (1958), are proportional to W and X coefficients, thus considerably extending the scope of the latter work.

14084 SOME INVESTIGATIONS IN THE THEORY OF OPEN-SHELL IONS. IV. THE BASIS OF INTENSITY THEORY.

J.S.Griffith.

Molecular Phys. (GB), Vol. 3, No. 5, 477-83 (Sept., 1960).

The basis of the theory of electric dipole intensities in centrosymmetric ions is critically examined. It is shown that the physical assumptions of one current version of this theory are mathematically inconsistent and the necessary revision of the theory is given. It is also pointed out that excitations from odd parity filled shells into the d shell should give a significant, and usually negative, contribution to the intensities.

14085 THE EFFECT OF BOND LENGTH VARIATIONS IN MOLECULAR ORBITAL CALCULATIONS OF π-ELECTRON SPECTRA—ANILINE.

T.E.Peacock.

Molecular Phys. (GB), Vol. 3, No. 5, 453-6 (Sept., 1960).

The effect of bond length changes on ground and excited state energies is examined. The results are applied to aniline.

14086 A SEMI-EMPIRICAL THEORY OF THE ELECTRONIC STRUCTURE OF ETHYLENE WITH PARTICULAR REFERENCE TO THE IONIZATION POTENTIAL.

Y.I'Haya.

Molecular Phys. (GB), Vol. 3, No. 6, 513-19 (Nov., 1960).

The electronic structure of the ethylene molecule is rescrutinized within the framework of the semi-empirical pi-electron theory. The lower electronic energy levels, twisting frequency, ionization potential and electron affinity are calculated without treating the so-called β parameter as empirical. A new approach for calculating the ionization potential is presented, in which an allowance is made for the change in the effective nuclear charge accompanying the actual ionization. The ionization potential is computed to be 10.757 eV, the observed value being 10.62 eV.

14087 A FURTHER STUDY ON THE ELECTRONIC STRUCTURE AND SPECTRUM OF ETHYLENE.

Y.I'Haya.

Molecular Phys. (GB), Vol. 3, No. 6, 521-31 (Nov., 1960).

See preceding abstract. Calculations on the lower electronic states, ionization potential and electron affinity of ethylene are carried out by a semi-empirical ASMO method including configuration interaction. The carbon—carbon sigma bonding electrons are explicitly included. One-centre quantities for ethylene, ethylene negative ion and ethylene positive ion are evaluated from atomic valence-state energies, taking account of changes in effective nuclear charges of the corresponding states. Two-centre electronic repulsion integrals are determined by interpolation between theoretical values for distant nuclear separations and one-centre repulsion integrals obtained; two-centre core integrals are computed purely theoretically. Good agreement between calculated and observed values is obtained. Although preferential stabilization of the ion cannot be expected from sigma-pi configuration interaction, it is shown that the reorganization of the electronic sub-structure of the atom upon ionization plays a significant role.

14088 ERRORS IN "WAVE FUNCTIONS FOR THE METHANE MOLECULE". I.M.Mills.
Molecular Phys. (GB), Vol. 4, No. 1, 57-9 (Jan., 1961).

See Abstr. 3409 of 1958. Two errors are corrected. They concern the f-harmonic approximation to the wave-function in the equilibrium configuration, for which the final expression for the wave-function, the energy lowering, and the density function were all in error.

14089 NATURE OF INTERMOLECULAR FORCES IN QUINHYDRONE. M.Chowdhury and S.Basu.
Proc. Nat. Inst. Sci. India A, Vol. 27, No. 3, 223-31 (May, 1961).

Taking molecular orbitals in their LCAO form, Mulliken's "Magic Formula" is used in the calculation of covalent bond energy of quinhydrone crystals. It is concluded that the covalent energy forms an insignificant part in the overall molecular interaction and only when there is accidental cancellation of large energy quantities like electrostatic, promotional and polarization energy, the interaction is governed by weak covalent bonding energy.

14090 THE PRECISE MEASUREMENT OF FREE RADICAL G-VALUES AND THEIR DEPENDENCE ON STRUCTURE.
M.S.Blois, Jr, H.W.Brown and J.E.Maling.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 234-55 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Factors involved in precise g-value measurements are discussed. g-values are given for positive and negative hydrocarbon ions and semi-quinone free radicals. The variation of g-value in various series of compounds is discussed in terms of the theory of McConnell and Robertson [J. phys. Chem. (USA), Vol. 61, 1018 (July, 1959)].
C.J.Ultee

14091 PARAMAGNETIC RESONANCE IN PHOSPHORESCENT AROMATIC HYDROCARBONS. II. DETERMINATION OF ZERO-FIELD SPLITTING FROM SOLUTION SPECTRA.
M.S.de Groot and J.H.van der Waals.
Molecular Phys. (GB), Vol. 3, No. 2, 190-200 (March, 1960).

For Pt I, see Abstr. 21080 of 1960. Electron paramagnetic resonance spectra are given of glassy solutions of triphenylene, 1, 3, 5-triphenylbenzene, coronene and naphthalene excited into their lowest triplet state by ultraviolet irradiation at liquid-nitrogen temperature. For each substance two spectra were measured: one with the r.f. magnetic field parallel to the constant field, the other with the fields at right angles. A method is suggested for analysing the spectra of those molecules having a trigonal symmetry axis and values of the zero-field splitting parameter are derived. A complete treatment for molecules of lower symmetry has not been given, but it is shown that previous results on a glassy solution of naphthalene are in agreement with those obtained by Hutchinson and Mangum with single crystals.

14092 DOUBLE QUANTUM TRANSITION IN ELECTRON SPIN RESONANCE OF DIPHENYL-PICRYL HYDRAZYL AT LOW MAGNETIC FIELDS. T.Hashi.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1243-8 (June, 1961).

Two radiation fields (ν_1 of about 150 Mc/s and ν_2 of 30, 20, and 15 Mc/s) are applied at static fields of about 50 gauss. The line shape, the peak position, and the intensity of the signal are well interpreted on the basis of the Bloch phenomenological equation (Abstr. 407 of 1948), choosing $T = 4.8 \times 10^{-8}$ sec, except for slight discrepancies near $H_0 = \omega_1/|\gamma|$. Some experimental results at $\nu_2 = 4.5$ Mc/s are also given.

14093 HYPERFINE INTERACTION IN THE DIPHENYL-PICRYLHYDRAZYL MOLECULE.
Yu.S.Karimov and I.F.Shchegolev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 3-9 (Jan., 1961).
In Russian.

The structure of the proton resonance line due to the magnetic interaction between the unpaired electron and the protons in the DPPH free radical was measured in fields from 500 to 5000 Oe, mainly at helium temperatures. When H/T is large enough, the resonance line splits into four components. One component is unshifted, one is shifted toward the low-frequency side, and the other two are shifted to the high frequency side. The twelve protons in DPPH can be assigned to the three shifted components in a manner that is consistent with the relative intensities of the lines. The existence of an unshifted line is unexpected and its origin remains unexplained. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 1-5 (July, 1961)].

14094 THE ANALYSIS OF COMPLEX NUCLEAR MAGNE
RESONANCE SPECTRA. I. SYSTEMS WITH ONE
OF STRONGLY COUPLED NUCLEI. J.A.Pople and T.Schaefe
Molecular Phys. (GB), Vol. 3, No. 6, 547-56 (Nov., 1960).

A general theory is presented of the high-resolution nucle
magnetic resonance spectra of systems in which two nuclei ha
relative chemical shift comparable with their spin-coupling co
all other relative chemical shifts being large. In the conventio
notation such systems may be described as ABR_pX_q..., where
are small integers. All such systems can be handled within on
theoretical scheme and the spectra, although possibly containi
many lines, can be built up as the superposition of spectra of
simpler types. The theory is illustrated by the analysis of the
proton resonance spectrum of trans-crotonaldehyde which, in
suitable solvents, is an example of ABR_3X.

14095 THE ANALYSIS OF COMPLEX NUCLEAR MAGNE
RESONANCE SPECTRA. II. SOME FURTHER
SYSTEMS WITH ONE STRONG COUPLING CONSTANT.
P.Diehl and J.A.Pople.
Molecular Phys. (GB), Vol. 3, No. 6, 557-61 (Nov., 1960).

The theoretical scheme described in Pt I (preceding abst
for the analysis of nuclear resonance spectra of the type ABX_q
extended to systems AB_2X_q where the symmetry is such that t
is only one BX coupling constant. It is shown that these spectr
can be interpreted in a systematic manner for all q. The spec
allow determination of the relative signs of all three coupling
constants and can therefore be used to compare couplings betw
nuclei of different species (AX and BX) with the coupling betwe
nuclei of the same species (AB). Further systems which could
studied by similar methods are indicated briefly.

14096 THE COUPLING BETWEEN ELECTRONIC AND
NUCLEAR MOTION AND THE RELATIVISTIC EF
IN THE GROUND STATE OF THE H_2 MOLECULE.
W.Kołos and L.Wolniewicz.
Acta phys. Polon. (Poland), Vol. 20, No. 2, 129-40 (1961).

The contribution to the binding energy of the hydrogen mol
due to the coupling between nuclear and electronic motion was
calculated. The wave-function employed was in the form of an
expansion in elliptic coordinates. The most reliable results
obtained with a four-term expansion is $\Delta D' = -5.1$ cm^{-1}. The
relativistic corrections calculated with a five term expansion
the binding energy by $\Delta D = -2.4 - E_2$cm^{-1}, where E_2, the classi
relativistic correction to the interaction between the electrons,
of the order of -1 cm^{-1} or smaller. The calculated correction
added to the accurate nonrelativistic result for infinitely heavy
nuclei give the theoretical binding energy $D = 38280$ cm^{-1}, the
experimental value being $D = 38286 \pm 6$ cm^{-1}.

14097 INTRINSIC EQUATIONS FOR THE DETERMINATI
SUSCEPTIBILITIES AND MAGNETIC SCREENING
CONSTANTS. J.Guy and F.Cabaret.
C.R. Acad. Sci. (France), Vol. 252, No. 19, 2854-6 (May 8, 196
In French.

It is shown that existing equations for the calculation of m
cular diamagnetic susceptibilities and of screening constants a
in nuclear magnetic resonance (see, for instance, Abstr. 379 o
1958) may be written in an alternative form which may be mor
convenient in practice.
E.F.W.Se

14098 ON THE CONTRIBUTION OF DISTANT MOLECUL
ORBITALS TO THE MAGNETIC SCREENING CON
ASSOCIATED WITH A NUCLEUS. J.Guy, F.Cabaret and J.R.D
C.R.Acad. Sci. (France), Vol. 252, No. 22, 3439-41 (May 29,196
In French.

By using the methods of the preceding abstract the single-
orbital screening constants for a distant nucleus can be expres
in terms of the anisotropy of a tensor related to the susceptibi
tensor. See also Abstr. 7485 of 1961.
J.Ha

14099 THE USE OF COMPLEX WIGGLE-BEAT PATTER
FOR THE ESTIMATION OF SMALL SPLITTINGS I
N.M.R. SPECTRA. J.J.Turner.
Molecular Phys. (GB), Vol. 3, No. 5, 417-24 (Sept., 1960).

The analysis of the "wiggle-beat" patterns produced by ra
passage through simple NMR multiplets is modified and extend
to permit analysis of beats from multiplets where adjacent sig
are not equally separated and where the intensities are not
necessarily in the ratio of the appropriate binomial coefficient
The simple example of mono-silane-d_1 (SiH_3D) is illustrated:

) = 0.427 ± 0.003 c/s. Allowance is also made for the finite e of passage through the signal and the usefulness of this demon- ated by analysing the beat pattern from the asymmetric spectrum mixture of SiH_3D and SiH_4. In this way the SiH_4—SiH_3D chemical ft is estimated to be 0.0080 ± 0.0005 p.p.m., the SiH_4 resonance ng to low field.

4100 DYNAMICAL JAHN—TELLER EFFECT IN MOLECULES POSSESSING ONE FOUR-FOLD SYMMETRY AXIS.

.Child.
lecular Phys. (GB), Vol. 3, No. 6, 601-3 (Nov., 1960).

For molecules with symmetry C_4, vibrations of types a_1 and b the components of an electronic manifold of type e. Under tain conditions the resulting matrix equation can be solved using ond-order perturbation theory. In this approximation it is shown there is no Jahn—Teller coupling between vibrations of the same e.

T.E.Peacock

14101 ISOTOPE SHIFTS IN THE N.M.R. SPECTRA OF H_2, HD AND D_2 DUE TO ZERO-POINT VIBRATION.

V.Marshall.
lecular Phys. (GB), Vol. 4, No. 1, 61-3 (Jan., 1961).

The variation with interatomic separation of the nuclear gnetic screening constant for H_2 has been studied in a previous er. Here an estimate is made of the difference in screening ch is a consequence of the different zero-point vibrational ctions in H_2, HD and D_2. The results are in good agreement h the observed values.

4102 NUCLEAR MAGNETIC SHIELDING AND DIAMAGNETIC SUSCEPTIBILITY OF INTERACTING HYDROGEN OMS.

T.W.Marshall and J.A.Pople.
lecular Phys. (GB), Vol. 3, No. 4, 339-49 (July, 1960).

A quantum-mechanical study is made of the changes of the lear magnetic screening constant σ and the diamagnetic suscepti- ty χ of two interacting hydrogen atoms due to van der Waals and rlap interatomic forces (effects of electron spin being neglected). large distances the calculations show that van der Waals forces rease the nuclear screening but increase the diamagnetic sus- tibility (in magnitude). As the inter-nuclear distance is reduced first effect of overlap forces is to increase the screening in the ulsive (electronic triplet) state but this is followed by a further uction. Attractive overlap forces (as in the ground state of H_2) mately lead to an increase in screening.

4103 MASER OSCILLATION ON 6—6 LINE OF $N^{15}H_3$.

I.Takahashi, T.Hashi, M.Yamano, M.Yamamoto, izuki and T.Makita.
Phys. Soc. Japan, Vol. 15, No. 3, 531-2 (March, 1960).

A comparison is made of maser oscillation using $N^{14}H_3$ 3 line) with $N^{15}H_3$ (6—6 line). The oscillation frequency of the er should not be so sensitive to focuser voltage and source ssure as N^{15} has no quadrupole moment. The samples used e natural ammonia and one containing 68% N^{15}. Variation of ensity of oscillation with source pressure and focuser voltage measured. The intensities appear to be somewhat influenced mutual interaction between $N^{14}H_3$ and $N^{15}H_3$ molecules.

J.M.Baker

4104 ELECTRON COUPLING OF PROTON SPINS IN HETEROCYCLIC MOLECULES. N-BENZYLTHIENO 2-b] PYRROLE.

H.S.Gutowsky and A.L.Porte.
hem. Phys. (USA), Vol. 35, No. 3, 839-44 (Sept., 1961).

The high-resolution proton magnetic resonance spectrum of four protons attached to the heterocyclic rings of N-benzyl- no [3, 2-b] pyrrole (I) was examined in detail at 16.2 Mc/s. The ctrum is of the type ABCD perturbed by two nuclei X_2 which ple with A, and it involves three long-range proton—proton plings, 0.5, 1.3 and 0.3 c/s over five, six, and six bonds, respectively ch can be accounted for only by pi-electron interactions. The lysis of the spectrum indicates that all of the coupling constants e the same sign, which is presumed to be positive on theoretical unds. This analysis illustrates the great value of obtaining mbiguous magnitudes of the coupling constants and chemical ts from high-frequency spectra in order to determine the tive signs of the coupling constants from low-frequency spectra. coupling constants found in each of the rings in I are compared those of the monocyclic compounds, thiophene and pyrrole. ough angular effects may govern the coupling via sigma electrons ICCH groups, the pi-electron contribution appears to be sensitive to electronegativity differences. In addition, heteroatoms and ionic structures are important in determining the long-range coupling via the pi electrons.

14105 NUCLEAR MAGNETIC RESONANCE SPECTRA OF VARIOUS OLEFINS. INFLUENCE OF A [MAGNETIC] FIELD ON SPECTRA OF THE TYPE ABX_2.

D.G.de Kowalewski and V.J.Kowalewski.
J. Phys. Radium (France), Vol. 22, No. 3, 129-34 (March, 1961).
In French.

The proton magnetic resonance spectra of 3-chloro-propenyl-benzene, cynnamic alcohol and anethole are studied and analysed as ABX_2 et ABX_3 systems. Formulae for frequencies and intensities are obtained. The ABX_2 system is studied as a function of the applied field. The chemical shift and spin—spin coupling parameters are determined for the above substances, and the values obtained are checked by using them to calculate the spectra for two different spectrometer frequencies.

HIGH RESOLUTION N.M.R. STUDIES OF INTRA- AND INTER-MOLECULAR INTERACTIONS. See Abstr. 12903

14106 FURTHER INVESTIGATIONS ON THE ELECTRONIC STRUCTURE OF FREE RADICALS.

I.S.Ciccarello, T.Garofano and M.Santangelo.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 256-8 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The hyperfine structure of various hydrazyls is investigated. In $(C_6H_5)_2NNCO(C_6H_5)$ an ortho (to the carbonyl) nitro group leads to a small further splitting of the five-line spectrum, while a nitro group in the para position has no effect on the spectrum. An attempt to observe the effects of the nitro-nitrogens in DPPH by N^{15} (in the NO_2) substitution was unsuccessful.

C.J.Ultee

14107 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF SOME FREE RADICALS PRODUCED BY IRRADIATION IN SOLIDS AT LOW TEMPERATURE.

R.Bensasson, K.Leibler, R.Marx and H.Szwarc.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 303-11 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The electron paramagnetic resonance spectra of free radicals generated by irradiation were studied in cyclohexane, cyclohexyl iodide, bromide and chloride and the vinyl monomers: acrylonitrile, methyl acrylonitrile, methyl acrylate and methyl methacrylate. The samples were irradiated at 77°K with from 10^6 to 7×10^6 r of 700 kV gamma rays. In cyclohexyl chloride the evidence is for the radical cyclohexyl but above 171°K there is evidence for the occurrance of another radical. The g-values splittings and recombination temperatures are given for all the cyclohexyl compounds mentioned above. The spectra of the vinyl monomers are also discussed and the spectrum for methyl methacrylate is analyzed in detail in terms of the radicals believed to be present and shows good agreement with theory. It is concluded that e.p.r. will be very valuable for this type of study when simple molecules and related structures have been studied to establish reference spectra to help in evaluating more complicated structures.

P.E.Seiden

14108 SELF-CONSISTENT FIELD THEORY OF THE ELECTRON SPIN DISTRIBUTION IN π-ELECTRON RADICALS.

A.D.McLachlan.
Molecular Phys. (GB), Vol. 3, No. 3, 233-52 (May, 1960).

In a radical the single determinant wave-function which gives the lowest electronic energy is one where electrons of opposite spins occupy different sets of molecular orbitals and thereby lower the "exchange" part of the energy. The unpaired spin density may be negative in a wave-function of this type and is easily found by perturbation theory if certain exchange integrals are small. It is shown that the spin density is then almost the same as is found by combining the usual single determinant function (with one unpaired electron, and 2n paired ones in n orbitals) with its singly excited doublet configurations. In alternant hydrocarbons the Pariser and Parr theory leads to a simple formula for the spin density: $\rho_r = c_{ro}^2 - \lambda \Sigma_s \pi_{rs} c_{so}^2$, where c_{ro} is the Hückel coefficient of the odd orbital on atom r, π_{rs} is the mutual polarizability of atoms r and s, and λ is a constant derived from the theory. The observed hyperfine structure in the electron resonance spectra of naphthalene, anthracene, perylene, diphenyl, phenanthrene, and pyrene negative ions agrees well with this formula, provided the constant Q defined by McConnell is about −24.2 gauss. The non-alternant negative ions of acenaphthylene and fluoranthene also agree, but not acepleiadylene. The theory predicts identical spin densities in corresponding positive and negative ions. In neutral alternant radicals negative spin densities are found on all the unstarred atoms of triphenylmethyl, perinaphthenyl, allyl, and benzyl. The calculated negative densities are a little too small to fit the spectra of the first two radicals, but fit just as well as valence bond ones.

14109 STABILIZATION OF FREE RADICALS AT LOW TEMPERATURES. SUMMARY OF THE N.B.S. PROGRAM

J.W.Moyer.
Nat. Bur. Stand. (USA), Monogr. No. 12, 100 pp. (1960).

A three-year research programme was undertaken at the National Bureau of Standards, Sept. 1956 to Oct. 1, 1959, under the sponsorship of the US Dept. of Defense. The book contains seven papers summarizing the status of the field of radical trapping, and the accomplishments of the programme; these papers were presented at the Fourth International Symposium on Free Radical Stabilization, held in Washington, DC, Aug. 1959. A summary account of the 1959 Symposium is given, together with a cross-referenced bibliography of 145 papers, 4 patents and a cine film resulting from the NBS programme.

14110 METHODS OF DETERMINING RADICAL CONCENTRATION BY ELECTRON-SPIN RESONANCE.

G.v.Foerster.
Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1079-81 (Dec., 1960).
In German.

Two methods are described for measuring sensitivity of an electron-spin resonance spectrometer, while actually loaded with the sample under investigation, for rapid and accurate estimation of radical concentrations in biological materials. In one method, spectra are recorded simultaneously with the spectrum of a comparison substance (e.g. magnesium arsenate) which shows fine structure. The unknown spectrum, which must be sharp enough not to obscure all the comparison spectrum, is measured relative to unobscured lines in the fine structure. The number of spins in the comparison sample need not be known, its spectrum being compared with absorption of a small probe containing diphenyl-picrylhydrazyl which can replace it in its location in a region of small radiofrequency magnetic field. In the second method, not limited to narrow lines, the unknown and a calibration sample (diphenyl-picrylhydrazyl) are successively placed in the main probe position, and in each case a comparison probe (also diphenyl-picrylhydrazyl) is introduced at a region of low radiofrequency magnetic field. The ratio of the increases in signal produced is the ratio of the sensitivities with the unknown and with the calibration sample in the main probe position. Integration procedures for line-area determination and corrections for differences in probe geometry are discussed in relation to the derivation of spin-numbers relative to a stated calibration substance. J.Sheridan

14111 A STUDY OF THE REACTIONS PRODUCED BY A BEAM OF MOLECULAR HYDROGEN IONS PASSING THROUGH NEUTRAL HYDROGEN AND HELIUM GAS. J.Guidini.

C.R. Acad. Sci. (France), Vol. 252, No. 19, 2848-50 (May 8, 1961).
In French.

Continues work of earlier paper (Abstr. 7030 of 1961) using improved H_2^+ beam having greater control over beam energy and using magnetic field rejection of unwanted ionic species. Two methods of determining collision cross-sections are discussed, one involving particle coincidence techniques and the other particle energy determinations. These methods agree to within about 2%. The dissociation, dissociation plus ionization and charge exchange cross-sections are measured for H_2^+ ions passing through neutral hydrogen and helium gas in the energy range 100-250 keV.
M.McChesney

14112 EXPERIMENTAL ESTIMATION OF THE DEGREE OF THE IONIC THERMAL DISSOCIATION OF THE CuI VAPOUR IN THE AIR ATMOSPHERE BETWEEN 350°C AND 550°C.

J.Mazur and J.Rafałowicz.
Brit. J. appl. Phys., Vol. 12, No. 10, 572-3 (Oct., 1961).

On the basis of measurements of the ionic current density in CuI vapour, the ionic pressure is evaluated as a function of temperature and compared with data given in the literature relating to the total CuI vapour pressure. It is thus possible to calculate the thermal ionic dissociation of CuI vapour as a function of temperature, and to plot the result.

14113 DIELECTRIC RELAXATION AND MOLECULAR STRUCTURE. K.Higasi.

Monogr. Res. Inst. Appl. Elect. (Japan), No. 9, 113+v pp.(1961

Critically reviews the various theories in this field and th application to experimental results, and finds all of them wanti some respect; particularly criticized are the concept of micro viscosity, attempts to use hybridization to explain away conjug and the use of the Cole—Cole plot for multiple relaxation time Careful discussions are given of diphenyl ether and related su stances, and of n-alkyl bromides. J.Ha

14114 ERRORS IN BOND ANGLES.

S.F.Darlow.
Acta cryst. (Internat.), Vol. 13, Pt 8, 683 (Aug., 1960).

The formula given by Ahmed and Cruickshank [Acta cryst. (Internat.), Vol. 6, 385 (1953)] for the standard deviations of bo angles is shown to be incorrect and the correct formula is der
R.F.S.Hea

14115 MOLECULAR STRUCTURE OF CYCLIC COMPOU CONTAINING SULPHUR. K.Hayasaki.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 679-90 (Dec 1960).

The electric dipole moments of trithiobenzaldehyde, trithi bromobenzaldehyde and newly synthesized trithio-p-chloroben hyde were measured. By using the observed values, the ring s turs of the trithiane derivatives and the atomic configurations two isomers of these compounds were investigated. The infra absorption and Raman spectra of 1:4-dithiane were measured, the ring structure of 1:4-dithiane was discussed. Furthermor the skeletal vibration frequencies of the ring were calculated according to the method developed by Wilson, assuming the Ur Bradley—Shimanouchi field to ascertain this result.

14116 DIPOLE MOMENT AND RELAXATION TIME OF CERTAIN TRI-SUBSTITUTED BENZENES.

J.Sobhanadri.
Indian J. Phys., Vol. 34, No. 12, 577-80 (Dec., 1960).

Dipole moments and relaxation times were determined fo trisubstituted benzenes from measurements at 3.26 cm. Benz was used as the solvent.

14117 EXPANSION OF MOLECULAR DIPOLE MOMENTS A FUNCTION OF THE COORDINATES OF SYMME

G.Graner.
J. Phys. Radium (France), Vol. 22, No. 4, 215-19 (April, 1961)
In French.

The present state of computations based on the intensitie infrared absorption bands is reviewed for di- and polyatomic cules, showing the relative importance of the different expansio terms of the dipole moment.

14118 THE ABSOLUTE DETERMINATION OF THE DIRECTION OF THE TRANSITION MOMENT AND DIPOLE MOMENT OF EXCITED MOLECULES BY THE MEAS MENT OF ELECTRIC DICHROISM. I. THEORY.

W.Liptay and J.Czekalla.
Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1072-9 (Dec., 19
In German.

An extension of the classical statistical theory of electric dichroism for polar molecules is developed so that in addition the band displacement produced by partial orientation, that pr duced by the field is taken into account. In suitable cases, the derived relations allow dipole moments, transition moments a their absolute directions, to be estimated for excited states.
W.J.Orville-T

14119 DIPOLE MOMENTS AND IONIC CHARACTER FO PCl_3, PF_3, AND NF_3. J.Sobhanadri.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 2, 110-4 (March 26,

A theoretical study of the dipole moments of PCl_3, PF_3, an NF_3 is made using the method of molecular orbitals. The amo of ionic character and sp-hybridization are estimated for thes molecules from the observed values of the dipole moments. T results are also discussed in the light of existing data on the nuclear quadrupole coupling constants in the case of NF_3.

14120 THE DIPOLE MOMENT AND END-TO-END LEN OF THE ISOTACTIC VINYL POLYMER. III. CONVERGENCE OF NEUMANN SERIES. T.Mori.

J. Phys. Soc. Japan, Vol. 16, No. 5, 944-9 (May, 1961).

For Pt II,see Abstr. 12344 of 1961. The theory of dipole ent and end-to-end length of the isotactic polymer is described. roblem of convergence of the infinite series in the matrix, . expresses a transformation of the bond vector, is studied ail, a skeletal chain of linear polymer being regarded as a r sum of many C—C bond vectors. The method of classifying ain configurations is given on the basis of the convergence rty of the series, which is an extension of the Neumann series. olymer chain must be Gaussian, if the segments of polymer otate independently of each other. The hindrance potential for ternal rotation is assumed to be of the square-well type.

:121 INTERMOLECULAR POTENTIAL AND PROPERTIES OF ARGON. I.S.Srivastava.

n J. Phys., Vol. 34, No. 12, 539-48 (Dec., 1960).

3y utilizing recent compressibility data, the potential field of 1 is determined on the Lennard-Jones (12 : 6) and (9 : 6) ls. The force constants thus determined on the L-J (12 : 6) l give a better correlation of the various properties of argon those obtained previously. A consideration of the equilibrium erties of argon lends support to the suggestion of Kihara r. 4261 of 1954; 4252 of 1956) that the potential bowl of the rical molecules should be wider than that given by the L-J 6) model.

122 DETERMINATION OF UNLIKE INTERACTIONS FROM BINARY VISCOSITY. I.B.Srivastava.

n J. Phys., Vol. 35, No. 2, 86-91 (Feb., 1961).

Experimental viscosity data for the binary gaseous mixtures A, Ne—A and H_2—propane are used to determine the potential meters for unlike pairs on the Lennard-Jones (12 : 6) model. e different methods are employed, the first method being icable only to mixtures exhibiting a maximum with respect to ations in the composition; the other two methods can be used ll gas pairs for which accurate viscosity data are available in de temperature range. The parameters thus obtained are lated, together with those from other sources.

4123 INTERMOLECULAR POTENTIALS OF H_2 AND D_2. I.B.Srivastava and A.K.Barua.

n J. Phys., Vol. 35, No. 6, 320-2 (June, 1961).

4124 SCATTERING OF HIGH-VELOCITY NEUTRAL PARTICLES. XII. He—CH_4; He—CF_4. CH_4—CH_4 AND -CF_4 INTERACTIONS. I.Amdur, M.S.Longmire and E.A.Mason.

em. Phys. (USA), Vol. 35, No. 3, 895-8 (Sept., 1961).

For Pt XI, see Abstr. 8825 of 1961. Collision cross-sections were sured for helium atoms with energies between 500 and 2100 eV, tered in room-temperature CH_4 and CF_4. The results have been ysed to obtain the average potential between a helium atom and $_4$ molecule,

$$\langle V(r)\rangle_{Av} = 602/r^{9\cdot43}\text{ eV},$$

between 1.92 and 2.37 A, and the average potential between a m atom and a CF_4 molecule,

$$\langle V(r)\rangle_{Av} = 6.18 \times 10^6/r^{17\cdot51}\text{ eV},$$

between 2.43 and 2.74 A. This He—CH_4 potential is consistent one valid at larger separation distances which has been obtained ombining potentials derived from high-temperature viscosity second virial coefficients of helium, and from high-temperature osity coefficients of methane. A procedure which assumes the res of force to reside in the peripheral H or F atoms has been to analyse these average atom—molecule interactions in terms e effective He—H and He—F interatomic potentials. These ratomic potentials have been combined with the potential previously rmined for He—He to obtain effective H—H and F—F potentials for ns in different CH_4 and CF_4 molecules. These effective interatomic ntials were then summed and averaged over all molecular orienta- s to yield the average potential between two CH_4 molecules,

$$\langle V(r)\rangle_{Av} = 5.64 \times 10^6/r^{15\cdot47}\text{ eV},$$

r between 2.47 and 3.06 A, and the average potential between CF_4 molecules,

$$\langle V(r)\rangle_{Av} = 1.17 \times 10^{22}/r^{30\cdot27}\text{ eV},$$

r between 3.43 and 3.77 A. This CH_4—CH_4 potential is consistent one valid at larger separation distances which has been derived n measurements on gaseous viscosity at high temperatures.

14125 TRANSITION PROBABILITIES IN MULTILEVEL SYSTEMS: CALCULATION FROM IMPULSIVE AND STEADY-STATE EXPERIMENTS. T.Carrington.

J. chem. Phys. (USA), Vol. 35, No. 3, 807-16 (Sept., 1961).

The study of collision-induced transitions of molecules in a system of many energy levels is discussed in an analysis of time-dependent and steady-state experiments. These results are used in a discussion, with numerical examples, of the difficulties in calculating the transition probabilities from observed population distributions. An intimate conceptual and mathematical relationship is established between two types of experiments which are possible at present. One is an impulse, or time-dependent experiment such as excitation with a fast flash lamp and snapshot observation after a known delay time. The other is a steady-state experiment in which molecules are fed into the system (a gas or a surface) at a single energy level, for example, and undergo transitions among the available levels in competition with a first-order removal process such as spontaneous radiation or desorption from a surface. The ideas summarized above are used to develop procedures for calculating transition probabilities from observed population distributions. Numerical examples and qualitative considerations indicate that when transitions involving more than single quantum jumps are involved, the experimental data must be known to much higher accuracy than that desired in the transition probabilities. The difficulties increase rapidly as the number of levels in the system increases.

14126 A THEORY OF ELECTRON IMPACT ON SOME POLYATOMIC MOLECULES. T.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 3, 510-28 (March, 1961).

A method by which a mass spectral pattern of a polyatomic molecule can be obtained from the data of appearance potentials of various ions and from optical measurement was obtained. It is theoretically expected that the total molecular ionization cross-section and relative yields of ions do not so much depend on the incident energy, except the low incident energy region, and that the total cross-section does not always rise linearly with the increase of incident energy at a threshold. Applications to CH_4 and CD_4 were carried out and the results are in plausible agreement with mass-spectroscopic data. In the course of the application, two ionized states ($^2A_1$, $^2T_2$) have been taken into account and it is assumed that the potential energy surfaces of ionized states are not so different from that of the ground state of the parent molecule with respect to almost all normal modes except one or two. It is also theoretically expected that there is a larger abundance of parent ion in the CD_4 case than in the CH_4 case by isotope effect. The experimental data shows the tendency predicted by the theory.

14127 ON THE ADDITIVITY RULE IN THE IONIZATION CROSS SECTION OF MOLECULES. T.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 3, 529-33 (March, 1961).

So far as the present calculation is concerned, it is concluded that the rule is considered to be approximately valid within the allowance of 20% under the condition where electrons are impacted with incident energies more than 80 eV and the internuclear distance between every couple of atoms in a molecule is more than 2.5 a_0. If the internuclear distance is less than 2.5 a_0, one must take account of the diffraction effects due to the interference of waves scattered by the neighbour atoms. Numerical computation was carried out to the cases of C_nH_{2n+2} and C_nF_{2n+2}. The results for C_nH_{2n+2} were found in plausible agreement with mass spectroscopic data but those for C_nF_{2n+2} were found to disagree slightly with data.

14128 INTERMOLECULAR FORCES FROM OPTICAL SPECTRA OF IMPURITIES IN MOLECULAR CRYSTALS. R.W.Zwanzig.

Molecular Phys. (GB), Vol.3, No. 4, 305-11 (July, 1960).

A procedure is outlined by which one can get information about the effects of electronic excitation on the interactions between molecules. The absorption and emission spectra of impurities in molecular crystals, and specifically the mean positions and widths of the lines, are required as functions of temperature. A theory of Lax (Abstr. 1247 of 1953) is used to relate mean position and width to intermolecular forces. The preliminary treatment of this problem by McCarty and Robinson (Abstr. 20661 of 1960) is evaluated and extended: their procedure is expected to be valid for very narrow lines only.

14129 THE CALCULATION OF DISPERSION FORCES.

L.Salem.

Molecular phys. (GB), Vol. 3, No. 5, 441-52 (Sept., 1960).

By means of second-order perturbation theory and the use of the closure approximation, a simple closed formula is developed for the dispersion energy of interaction between spherical systems or molecules with axial symmetry. This expression contains an explicit two-electron correlation term. Agreement with experiment is most encouraging and is ascribed to the inclusion of this correlation term.

14130 THE THIRD VIRIAL COEFFICIENT AND THE FORCE BETWEEN MOLECULES.

J.Bahadur and M.P.Madan.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 1, 64-8 (Jan. 26, 1960).

The data on the third virial coefficient are discussed for a few gases based on the Lennard-Jones 12 : 6 potential energy function, and are employed to estimate the potential parameters using a simple graphical method. The values of the parameters are compared with other determinations and a reasonable agreement is found.

14131 DIFFERENTIAL AND TRANSPORT CROSS-SECTIONS FOR CLASSICAL SCATTERING BY REPULSIVE POTENTIALS.

E.M.Baroody.

Phys. of Fluids (USA), Vol. 4, No. 9, 1182-3 (Sept., 1961).

A procedure for determining the differential scattering cross-section by expanding the repulsive part of the intermolecular potential is given in terms of the index characterizing the general power, and a simple exponential law is proposed. Results are compared with tabulated values of inverse twelfth-power and exponential potentials and good agreement is found.

M.McChesney

14132 THE FORCES BETWEEN POLYATOMIC MOLECULES. I. LONG-RANGE FORCES.

H.C.Longuet-Higgins and L.Salem.

Proc. Roy. Soc. A (GB), Vol. 259, 433-41 (Jan. 24, 1961).

It is known that the electrostatic long-range forces between two molecules are "locally additive" in the sense that the first-order interaction energy between molecules bearing charges or permanent multipole moments may be written as a double integral over pairs of points, one in each molecule. In this paper the second-order interaction energy is examined, which comprises polarization and dispersion terms, and it is found that the corresponding forces are locally additive or not according as the electron correlation within each molecule does or does not die away rapidly with distance.

14133 MOLECULAR WEIGHT DISTRIBUTION FROM THE NORMAL COORDINATE THEORY OF VISCOELASTICITY.

E.Menefee and W.L.Peticolas.

J. chem. Phys. (USA), Vol. 35, No. 3, 946-50 (Sept., 1961).

The normal coordinate theory of viscoelasticity is shown to provide a bridge between the measurable rheological properties of linear polymers and their molecular weight distribution functions, as well as their average molecular weights. Equations are derived relating the molecular weight distribution function of a linear polymer to a sum of functions of a measurable rheological property such as stress relaxation or dynamic viscosity. Thus, a method for the simple and rapid determination of molecular weight distribution is developed within the limitations of the normal coordinate theory.

14134 MOLECULAR-WEIGHT DEPENDENCE OF THE VISCOELASTIC PROPERTIES OF WHOLE POLYMERS.

W.L.Peticolas and E.Menefee.

J. chem. Phys. (USA), Vol. 35, No. 3, 951-4 (Sept., 1961).

A method is developed by which it is possible to determine the type of molecular weight averaging upon which viscoelastic properties of polymers may depend and which may be used to verify the normal-coordinate theory of viscoelasticity for various types of polymers. The method is extraordinarily simple to carry out since it involves only measurement of the property on whole polymers and mixtures of whole polymers. Neither fractionation nor molecular-weight measurements themselves are required. Methods of determining the correct average-molecular-weight dependence of melt viscosity and steady-state elastic compliance are worked out in detail and are illustrated with data on linear polyethylenes. The method is also applicable to other polymer properties which are molecular-weight dependent.

14135 ON THE VISCOSITY OF IRRADIATED POLYMER
III. EFFECT OF BRANCHING. K.Katsuura.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2310-17 (Dec., 1960).

For Pt II see Abstr. 20701 of 1960. The intrinsic viscosi
an irradiated polymetric substance is calculated with inclusio
the effect of branching. The contribution of a branched polym
the intrinsic viscosity is evaluated according to Debye—Buech
theory (Abstr. 3641 of 1948) with some modifications. The di
bution of molecular size and crosslink unit is obtained throug
extention of the Saito's theory (Abstr. 10211 of 1959). The re
agree with experiment fairly well. The essential reason for t
large discrepancy between Saito's calculation and experiment
shown to be his neglect of branching.

14136 THE MOLECULAR STRUCTURE AND MECHANI
PROPERTIES OF POLYETHYLENE TEREPHTH
FIBERS.

I.M.Ward.

Textile res. J. (USA), Vol. 31, No. 7, 650-64 (July, 1961).

The application of several techniques of molecular struc
determination to polyethylene terephthalate (PET) polymer a
fibres is described. These investigations were directed part
towards obtaining an understanding of the dynamic mechanica
properties of PET and related polymers and partly to the cha
erization of PET fibres with respect to crystallinity and orie
In considering the dynamic mechanical properties of PET an
relationship to the molecular structure two main points were
investigated: first whether the dynamic mechanical transitio
be related to specific motions of the molecular chains and se
whether the influence of crystallinity and orientation can be s
understood.

14137 SYMMETRY OF CHAIN MOLECULES.

B.K.Vainshtein.

Kristallografiya (USSR), Vol. 4, No. 6, 842-8 (Nov.-Dec., 195
In Russian.

Several problems in the geometry of chain molecules are
sidered. From symmetry groups of three-dimensional figure
periodic in one direction ("pivotal" groups), one can obtain g
characteristic for chain molecules. [English translation in:
Physics—Crystallography (USA), Vol. 4, No. 6, 801-6 (June,

14138 THE HELIX-COIL TRANSITION IN CHARGED MACROMOLECULES.

B.H.Zimm and S.A.Rice.

Molecular Phys. (GB), Vol. 3, No. 4, 391-407 (July, 1960).

Starting from the Grand Partition Function and using ma
methods introduced previously (Abstr. 10216 of 1959), a form
of the theory of helix-coil transitions in charged macromolec
given. The theory is compared with experimental data for th
system polyglutamic acid-dioxane-water-NaCl. If the param
describing the extra difficulty associated with initiating a hel
configuration is assigned the same value as for polybenzylglu
the calculations are in excellent agreement with experiment.
analysis of the physical significance of the Grand Partition F
leads to methods for determining the fraction of polymer in h
form, the equilibrium constant for the addition of a residue t
already formed helix, as well as the initiation parameter me
above. The value of the initiation parameter deduced from ti
data on polyglutamic acid is in rough agreement with the valu
polybenzylglutamate. The nature of the approximations used
discussed briefly.

14139 VARIATIONAL TREATMENT OF ELECTRONIC
MESONIC HYDROGEN MOLECULE IONS.

A.Fröman and J.L.Kinsey.

Phys. Rev. (USA), Vol. 123, No. 6, 2077-83 (Sept. 15, 1961).

The Schrödinger equation for three Coulombic particles
formally reduced to an internal one. Solutions to this equatio
sought via the variation principle without recourse to the Bor
Oppenheimer expansion. Some calculations for electronic an
mesonic isotopic hydrogen molecule ions demonstrate that e
very simple trial functions give results comparable to those
obtained from conventional Born—Oppenheimer treatments bu
with considerably less labour. Values for the total energies
internuclear distances for the ground and two lowest excited
states are reported along with the separation of the centres o
positive and negative charge which exists when the two nuclei
have different masses.

14140 NON-ADIABATIC EFFECTS ON THE BOUND ST
OF THE μ-MESONIC PROTON—DEUTERON SYS

H.Narumi and S.Matsuo.

Progr. theor. Phys. (Japan), Vol. 25, No. 2, 290-2 (Feb., 196

Various energy levels are calculated by a non-adiabatic
method. R.J.N.

SOLID-STATE PHYSICS

4141 MIDWEST SOLID STATE CONFERENCE.
F.T.Phelps.
;. Today (USA), Vol. 14, No. 6, 44 (June, 1961).
Report of a conference held at the University of Nebraska
21-22, 1960. The papers (approximately 20) covered a wide
e of interest. Four papers on the Fermi surface combined to
e this the dominant topic of the conference.

4142 CONVEX-CORE MODEL OF MOLECULES IN CRYSTALLINE STATE. II. S.Koba.
hys. Soc. Japan, Vol. 16, No. 4, 627-32 (April, 1961).
For Pt I see Abstr. 13768 of 1959. The convex-core model of
ecules, which has been effective for discussing thermodynamic
erties of polyatomic gases, is applied to the crystals of
zene and ethylene as a continuation of a previous article of the
e title, in which crystals of methane, CO_2 and N_2 were treated
ise of model parameters determined from the second virial
ficients, cohesive energies and lattice constants are calculated.
n we neglect zero-point energies, potential non-additivities,
electric multipole interactions, then the calculated cohesive
gies are close to the observed values for benzene and 16%
er for ethylene. The calculated lattice constants agree well
observed ones in both cases. Stability of the benzene crystal
iscussed, but the conclusions are not as definite as in the case
O_2

4143 COHESIVE ENERGIES OF EUROPIUM, GADOLINIUM, HOLMIUM, AND ERBIUM.
.Trulson, D.E.Hudson and F.H.Spedding.
hem. Phys. (USA), Vol. 35, No. 3, 1018-26 (Sept., 1961).
A mass spectrometric method was employed to study the
d—gas phase change in four rare-earth metals. The enthalpies
ublimation in kcal/M reduced to 298°K are: Eu, 43.11 ± 0.25;
81.22 ± 0.32; Ho, 75.04 ± 0.44; and Er, 75.39 ± 0.34. The
esponding cohesive energies in kcal/M as determined from
sently available thermodynamic data are: Eu, 43.4; Gd, 81.9;
75.5; and Er, 75.7. A summary of the cohesion in the rare-
h series is included. A qualitative explanation of the unexpected
ations is given in terms of the energetics of the metallic and
eous states.

CONTRIBUTION OF THERMAL LATTICE DEFECTS TO
ANSION IN PURE METALS. See Abstr. 14289

4144 PLASTIC CRYSTALS AND ROTATION IN THE SOLID STATE.
hys. Chem. Solids (GB), Vol. 18, No. 1, 1-92 (Jan., 1961).
Proceedings of a symposium held in the Inorganic Chemistry
oratory, Oxford University, 5 and 6 April, 1960. The symposium
supported by the US Department of the Army, through its
opean Research Office. Nine invited papers were presented,
owed by eight contributed papers. Abstracts of the papers will
ear in this or subsequent issues of Physics Abstracts.

14145 EQUILIBRIUM PROPERTIES OF CRYSTALLINE ARGON, KRYPTON AND XENON.
.Guggenheim and M.L.McGlashan.
ecular Phys. (GB), Vol. 3, No. 6, 563-70 (Nov., 1960).
By assuming an interaction energy for krypton and xenon of the
e shape as that established for argon in an earlier paper and
out introducing any adjustable parameters, values of the
ilibrium properties of the crystals are calculated which agree
the measured values to within the experimental accuracy or to
in 1%.

14146 THE CALCULATION OF THE MADELUNG CONSTANT OF A "GENERALIZED" SODIUM CHLORIDE LATTICE.
.Waddington.
ns Faraday Soc. (GB), Vol. 56, Pt 3, 305-9 (March, 1960).
A formula has been developed for the calculation of the
elung constants of distorted sodium-chloride type lattices
ch have tetragonal or orthorhombic symmetry by an extension
he formula of Benson for sodium chloride itself. The expression
xtremely rapidly convergent.

14147 TABLE OF HUND'S CUBIC BASIC POTENTIAL $\Psi(q/24)$, WITH EXPLANATORY NOTES ON HUND'S METHOD OF CALCULATING MADELUNG'S COEFFICIENT.
U.Takahasi and Y.Sakamoto.
J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 1, 117-30 (July, 1960).

The determination of the Madelung coefficient by the linear combination of particular terms of Hund's basic potential has been frequently employed for various ionic crystals. Numerical tables and graphs of the cubic $\Psi(q/24)$ are given, and a relation between $\Psi(q/24)$ and $\Pi(p/n)$, the basic Born potential, is indicated.

C.A.Hogarth

14148 ATOMIC ENERGY LEVELS IN CRYSTALS.
J.L.Prather.
Nat. Bur. Stand. (USA), Monogr. No. 19, 84 pp. (1961).

Discrete energy levels observed within certain crystals are treated as due to perturbations of the energy levels of the free ion by an electrostatic field arising from the crystal lattice. The analytic procedures for determining the field from the charge configuration are given, and the resulting fields are classified according to their symmetry. After a general survey of group-theoretical ideas, the applicable groups are analysed in detail, and characters appropriate for both integral and half-integral angular momenta of the free ion are tabulated. These are applied to the determination of the number and type of levels arising from a free ion level with $J \leq 8$. The results of this analysis are tabulated, as are the selection rules for electric dipole, magnetic dipole, and electric quadrupole transitions. Calculation of the perturbation matrix elements by the use of Wigner and Racah coefficients is discussed. Examples of the application of these several techniques to specific problems are given.

14149 CHARGE DISTRIBUTION AND ELECTRIC FIELD GRADIENTS IN IONIC CRYSTALS.
G.G.Belford, R.A.Bernheim and H.S.Gutowsky.
J. chem. Phys. (USA), Vol. 35, No. 3, 1032-8 (Sept., 1961).

A method is presented by means of which one can investigate the validity of the point-charge model often used for the calculation of electric field gradients in ionic crystals. The asymmetry parameter of the electric field gradient at a nucleus and the Eulerian angles describing the orientation of the field gradient's principal axes with respect to the crystallographic axes are linear functions of the point charges assigned to each set of atoms in the lattice. If the unit cell is of low symmetry and if there are more than one set of nuclei for which quadrupole interaction data can be observed, the number of observables and equations may equal or exceed the number of unknown charges, thereby enabling the charge distribution to be determined and its internal consistency checked. Such is the case for spodumene, for which the charge distribution thus calculated is neither internally consistent nor very reasonable. An analysis is made of the sensitivity of the apparent charge distribution to experimental errors in the quadrupole interactions, and the errors are found to be much too small to account for the anomalies. However, further investigations, including a refinement of the crystallographic parameters of spodumene, are necessary before the anomalies could be attributed to deficiencies in the point-charge model. With allowance for the uncertainties in the charge distribution, the analysis lends some support to a value of ~ 0.04 b for Q_7, the nuclear quadrupole moment of Li^7. Further charge distribution anomalies result from a similar, but less detailed treatment of another silicate, beryl, which gives a very approximate value of $Q_9 \sim 0.1$ b for Be^9.

14150 A METHOD FOR CALCULATING INTERNAL FIELDS IN COMPLEX DIPOLE STRUCTURES.
S.P.Solov'ev, Yu.N.Venevtsev and G.S.Zhdanov.
Kristallografiya (USSR), Vol. 5, No. 5, 718-25 (Sept.-Oct., 1960).
In Russian.

In its general form the problem of calculating the fields is reduced to the solutions of a system of linear equations with 3m unknowns, where m denotes the number of atoms in a unit cell. Consideration of structural symmetry permits the reduction of the number of unknowns to 3n, where n is the number of complexes, and $n < m$. In order to calculate all the structure sums necessary for calculating the fields, one can use Ewald's method (1921) successfully. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 686-93 (March-April, 1961)].

14151 THE INTERNAL FIELDS IN THE ORTHORHOMBIC FORM OF BaTiO$_3$.

G.S.Zhdanov, S.P.Solov'ev, Yu.N.Venevtsev and V.V.Ivanova.
Kristallografiya (USSR), Vol. 4, No. 6, 855-61 (Nov.-Dec., 1959).
In Russian.

Calculations are given for the internal fields in the orthorhombic form of BaTiO$_3$. The effects of some cations of those fields are examined, as is the polarization of ferroelectrics based on that form. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 812-17 (June, 1960)].

14152 THEORY OF TRANSITION ION COMPLEXES.

W.Marshall and R.Stuart.
Phys. Rev. (USA), Vol. 123, No. 6, 2048-58 (Sept. 15, 1961).

It is suggested that the observed lowering of the spin—orbit parameters in transition-ion complexes in crystals is caused by a screening effect which expands the 3d wave-functions. Evidence in support of this suggestion is given by neutron diffraction form-factor measurements on Mn^{2+} salts. The theory of the transferred hyperfine interaction between the electron spin of Mn^{2+} and surrounding F^{19} nuclei is discussed, and the complications introduced into the theory when dealing with other ions are described. The theory is found to be unsatisfactory because it is not possible to treat the interaction via the 1s orbitals of F$^-$ with sufficient accuracy.

14153 PARAMAGNETIC SUBSTANCES FOR NUCLEAR ORIENTATION.

R.P.Hudson.
Progress in cryogenics, Vol. 3 (see Abstr. 13029 of 1961) p.97-127.

The technique of magnetic cooling of paramagnetic salts to achieve orientation of their constituent nuclei is discussed in detail. The choice of the cooling substance involves a consideration of the nuclear orientation process, the energy levels, the calculation of orientation parameters and the effect of interaction on the degree of orientation. Individual substances discussed include Tutton salts, double nitrates, ethyl sulphates, fluosilicates and rubidium actinyl nitrates. 76 references. J.B.Birks

14154 DYNAMIC NUCLEAR ORIENTATION.

C.D.Jeffries.
Progress in Cryogenics, Vol. 3 (see Abstr. 13029 of 1961) p.129-73.

This review considers the solid-state aspects of dynamic nuclear orientation at low temperatures. Methods discussed include paramagnetic resonance saturation, which is treated in detail for the cases of strong and weak static hyperfine coupling and contact hyperfine coupling, ferromagnetic and antiferromagnetic resonance saturation, orientation by hot conduction electrons, and acoustic excitation. Techniques and apparatus are described, and an account is given of the applications and results obtained in the orientation of radionuclei, nuclear orientation by dipolar coupling, dynamic nuclear cooling and the Overhauser effect in metals, semiconductors and free radicals. J.B.Birks

14155 POLARIZATION OF SOME RADIOACTIVE ISOTOPES IN ALLOYS.

A.V.Kogan, V.D.Kul'kov, L.P.Nikitin, N.M.Reinov, I.A.Sokolov and M.F.Stel'makh.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 109-13 (Jan., 1961).
In Russian.

Polarization of the nuclei of the radioactive isotopes Au^{199}, Ir^{192}, Ir^{191m}, Re^{186} and V^{48} alloyed with iron was studied at ultra-low temperatures. The magnetic field acting on the nuclei of the isotope mixture was $H_{eff} \geq 2 \times 10^6$ Oe for Au^{199}, $H_{eff} \geq 2 \times 10^5$ Oe for Re^{186}, and $H_{eff} \sim 10^6$ Oe for Ir^{192}. No polarization was found in the Ir^{191m} isomer produced as a result of β decay of Os^{191m} introduced in the iron or in V^{48} in an alloy containing iron and 2% titanium. The comparatively small value of H_{eff} for Re^{186} may be due to the large disorientation of the nuclei during the β-transition. The increase in the value of H_{eff} with the atomic number of the weakly magnetic mixture is in qualitative agreement with the theory proposed by Marshall (Abstr. 1057 of 1958). [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 78-80 (July, 1961)].

14156 SURFACE STATES IN A FINITE CRYSTAL.

P.Phariseau.
Physica (Netherlands), Vol. 27, No. 6, 590-2 (June, 1961).

A previous investigation (Abstr. 7548 of 1961) of the properties of the surface states of a one dimensional semi-infinite crystal is here extended to describe a finite specimen. Each atom is represented by a δ-potential energy function and the wave-functions are expressed by appropriate Green's functions. The chain consists here of 2n + 1 identical atoms and groups of 2n + 1 energy levels are obtained. These may be arranged respectively with 2n + 1; 2n or 2n − 1 levels in each Kronig—Penney band and th fore with 0:1 or 2 surface levels. These results agree with th obtained by using a scattering matrix treatment. A more deta report is to be published later. P.

14157 ATOMIC COLLISION SEQUENCES IN CRYSTALS COPPER, SILVER AND GOLD REVEALED BY SPUTTERING IN ENERGETIC ION BEAMS.

R.S.Nelson and M.W.Thompson.
Proc. Roy. Soc. A (GB), Vol. 259, 458-79 (Jan. 24, 1961).

Specimens of copper, silver and gold were bombarded wit 0.3 MeV protons and 10 keV ions of argon and xenon. Atoms w ejected from crystal surfaces with maximum intensity along l index crystal directions. The effects are interpreted as being to the arrival at the surface of three types of focused atomic collision sequences. The first travels along ⟨110⟩ directions, momentum being focused by the geometrical properties of a c packed line of spheres. No mass transfer is thought to occur i this type of sequence and experiment shows its maximum rang gold to be roughly 350 A. The second and third types travel a ⟨110⟩ and ⟨111⟩ directions, and are thought to consist of succ collisions in which the projectile atom replaces the target; foc being due to the rings of atoms which encircle the projectile's s A theoretical study shows these rings to behave with formal similarity to the converging lens in optics, and an upper energ limit for focusing is derived. It is predicted that the maximur ranges in copper are roughly 35 A for ⟨100⟩ sequences and 12 for ⟨111⟩ sequences, the corresponding values in gold being 5 300 A, respectively. These predictions are shown to be in agr ment with experiment.

LATTICE MECHANICS

14158 ON THE THEORY OF CRYSTAL LATTICES WIT CENTRAL INTERATOMIC FORCES.

V.S.Oskotskii and A.L.Éfros.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 611-24 (Feb., 1961).
In Russian.

The most general form of the lattice energy density is us the harmonic approximation for a given set of atomic displac with a non-central interaction. Using the method of homogen static deformation, the authors obtain an expression for the e constants in terms of the parameters of the microscopic theo The conditions for the elimination of all the components of th stresses are derived. The elastic constants agree with those culated by the long wave method. A relation is derived betwe parameters which describe the energy density and the dynam matrices. [English translation in: Soviet Physics—Solid State Vol. 3, No. 2, 448-57 (Aug., 1961)]. M.G.P

14159 STUDY ON THE INTERNAL MOTIONS OF SOME ACRYL- AND METHACRYL-GROUP HIGH POLY BY PULSED N.M.R. METHOD.

T.Kawai.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1220-5 (June, 1961).

The internal motions of some high polymers were invest by measuring the spin—lattice relaxation time (T_1) together w minima ($T_{1\ min}$) in proton resonance in the temperature rang liquid air up to about 300° C by a pulsed n.m.r. method at 25 For acryl-group high polymers (polymethylacrylate, polyethy acrylate, polybutylacrylate), two minima of T_1 were observed a higher temperature corresponding to the segmental motion other at a lower temperature corresponding to the internal m the side chain ester alkyl group. For methacryl-group high (polymethylmethacrylate, polyethylmethacrylate, polybutylme acrylate), three minima of T_1 were observed, of which the on highest temperature corresponds to the segmental motion, th at the middle temperature to the internal motion of both the r chain methyl group and the side chain ester alkyl group and t at the lowest temperature to the internal motion of the latter alone. Thus the internal motions of amorphous high polymer be definitely separated. The rigorous analysis of the behavi considered to be a rather difficult problem, because of the c ity of the circumstances and the lack of both existing suitable formulae and precise experimental data.

160 POLARIZATION WAVES IN SOLIDS.
T.Kurosawa.

ıys. Soc. Japan, Vol. 16, No. 7, 1298-1308 (July, 1961).
A general theory of polarization waves in crystals is developed
nnection with the optical and the dielectric properties of the
tals. The result includes, in more general form, the relations
igeti (Abstr. 2104 of 1951) and Fröhlich [Theory of Dielectrics.
rd: Clarendon Press (1949), para. 18] about the lattice vibra-
in ionic crystals and the theory by Heller and Marcus for the
on (Abstr. 2243 of 1952). The theory is applied to the analysis
e infrared data of $BaTiO_3$-type crystals.

161 ON THE FREQUENCY SPECTRA OF SOLIDS AS CALCULATED FROM EXPERIMENTAL SPECIFIC
TS. V.Hovi and Y.Pautamo.

Acad. Sci. Fennicae A VI (Finland), No. 68, 17 pp. (1960).
A method is presented for the determination of the frequency
tra of solids from the specific heat data. It is based on the
ion of a system of linear equations. By using experimental
ific heats measured by Berg and Morrison (Abstr. 162 of 1958),
ency distributions were calculated for NaI, KCl, KBr and KI.

162 ON THE VIBRATIONAL AND ZERO POINT ENERGIES OF ALKALI HALIDES. V.Hovi and Y.Pautamo.

Acad. Sci. Fennicae A VI (Finland), No. 84, 12 pp. (1961).
By using the lattice vibrational spectra determined by Karo and
vi and Pautamo zero-point energies were evaluated for all the
i halides of sodium chloride structure. For these substances
ero-point energies were calculated also by making use of the
e distribution. The vibrational energy as a function of tempera-
was determined from specific heats. The values obtained for
tional energies (in five figures) against absolute temperature
iven in the range 0-600°K. The temperature dependence of
encies and its influence on the vibrational energy is discussed.

163 ERRATUM: LATTICE ENERGIES OF THE ALKALI HALIDES AND THE ELECTRON AFFINITIES OF THE
OGENS. D.Cubicciotti.

em. Phys. (USA), Vol. 34, No. 6, 2189 (June, 1961).
See Abstr. 2783 of 1960. An error in the calculation of zero-
energies is corrected.

164 LIMITING OPTICAL FREQUENCIES IN ALKALI HALIDE CRYSTALS. A.A.Maradudin and G.H.Weiss.

. Rev. (USA), Vol. 123, No. 6, 1968-94 (Sept. 15, 1961).
Rosenstock (Abstr. 2371 of 1961) recently has used symmetry
ments to show that the frequencies of the three optical branches
ionic crystal in the limit of infinite wavelengths are all equal.
result is in contrast with the relation $(\omega_l/\omega_t) = (\epsilon_0/\epsilon_\infty)^{1/2}$ due
ddane, Sachs, and Teller (Abstr. 1283 of 1941), where ω_l
$_t$ are the limiting longitudinal and transverse frequencies
$_0$ and ϵ_∞ are the static and high-frequency dielectric constants,
ectively. By use of Kellerman's model for NaCl the present
r obtained the small-k expansions of the elements of the
mical matrix for a finite spherical crystal of radius R. It is
that, if the limit k → 0 is taken before the limit R → ∞, the
optical frequencies are all equal, while if the order of taking
s is reversed the result of Lyddane, Sachs, and Teller is
ned. These conclusions are in agreement with Rosenstock's
lt, and with remarks of Fröhlich (Theory of dielectrics.
öhlich 2nd ed. New York: Oxford University Press (1958)
9), and provide an explicit expression for the infrared
ency in the finite-crystal case. A similar calculation for
er's low-density electron crystal (1934, 1938) yields the result
in a finite spherical crystal the limiting frequencies of the two
verse branches and the one "longitudinal" branch are all equal.
possibility of the experimental observation of these effects is
ssed.

165 LONG-WAVE OPTICAL VIBRATIONS IN SIMPLE IONIC CRYSTALS. T.H.K.Barron.

. Rev. (USA), Vol. 123, No. 6, 1995-8 (Sept., 15, 1961).
This paper resolves some of the difficulties recently pointed
y Rosenstock (Abstr. 2371 of 1961), in the theory of the
e vibrations of ionic crystals of NaCl or CsCl structure.
optical waves in these crystals (but not in crystals with only
t-range forces) are seen to be purely longitudinal and trans-
e. With the electrostatic approximation, the Lyddane—Sachs—
r equation $(\omega_l/\omega_t)^2 = \epsilon_0/\epsilon_\infty$ (Abstr. 1283 of 1941), holds
endently of the boundary conditions for modes in which the
e of the ionic vibrations is effectively constant over distances
h are large compared with the lattice spacing; such modes must be either curl-free or divergence-free, with respective frequencies ω_l and ω_t. If both curl and divergence vanish, the frequency is indeterminate unless boundary conditions are specified, so that there is a singularity but no inconsistency as the wave number k → 0. When Coulomb retardation is taken into account this singularity disappears, and the frequency at k = 0 is found to be ω_l; the range of validity of the Lyddane—Sachs—Teller equation is then $10^{-4} \gtrsim k^{-1} \gtrsim 10^{-6}$ cm. Reasons are given for believing that the cyclic boundary condition is valid for the thermodynamic properties of large ionic crystals, though this is not proved rigorously; specific boundary conditions may, however, be important in reflection and absorption of infrared radiation.

14166 THE EFFECT OF CRYSTAL ANISOTROPY ON THERMAL VIBRATIONS OF ATOMS IN GERMANIUM AND SILICON. A.G.Samoilovich and V.D.Iskra.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2827-33 (Nov., 1960).
In Russian.

Deals with the spectrum and polarization of acoustic phonons in germanium and silicon. Shows that an anisotropic germanium or silicon crystal may be replaced by an equivalent elastically isotropic crystal with modified elastic constants. Anisotropy of the phonon spectrum in germanium and silicon is discussed. [English translation in: Soviet Physics—Solid State (USA)].

A.Tybulewicz

14167 VIBRATIONAL SPECTRA OF DIATOMIC CHAINS. II.
P.Dean.

Proc. Roy. Soc. A (GB), Vol. 260, 263-72 (Feb. 21, 1961).

For Pt I see Abstr. 7845 of 1960. Contains the results of spectral computations on disordered diatomic chains in which the proportion of light to heavy atoms is varied. Peaks which occur in the spectra are shown to be associated with certain kinds of localized chain structure and are labelled accordingly.

14168 FORCES OF IONIC INTERACTION AND EQUATIONS OF IONIC LATTICE VIBRATIONS FOUND BY MEANS OF A MANY-ELECTRON MODEL OF IONIC STATES AND AN ADIABATIC APPROXIMATION. K.B.Tolpȳho.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 72-91 (1959). In Ukrainian.

The author's theory (1949-56) of ionic lattice vibrations, based on the quantum-mechanical consideration of ionic states, is generalized by considering the crystal electron system as a whole. In the adiabatic approximation an expression is derived for the crystal potential energy as a function of the displacement of nuclei and the dipolar moments of their electron shells. In contrast to the assumptions made in previous work [Zh. eksper. teor. Fiz. (USSR), Vol. 20, 497 (1950)], the potential energy is not written down in the form of a sum of paired interacting ions but contains terms which depend on the coordinates of three neighbouring nuclei. These additional terms are of a non-central nature and become more significant with a poorer approximation of strongly coupled electrons. A grounding of the results obtained in the author's previous papers, which were based on special assumptions, is given in harmonic approximation. An equation is derived for the vibrations of crystal ionic lattices of the NaCl, CsCl and ZnS types.

14169 DETERMINATION OF THE FREQUENCY SPECTRUM OF PHONONS IN CRYSTALS. Yu.Kagan.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 312-18 (Jan., 1961).
In Russian.

For crystals of arbitrary symmetry, the problem is considered of determining the phonon frequency spectrum, in connection with the investigation of one-phonon transitions in the Mössbauer effect and incoherent scattering of "cold" neutrons. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 211-15 (July, 1961)].

14170 A THEORY OF SOUND ABSORPTION IN UNIAXIAL FERROMAGNETIC DIELECTRICS.

M.I.Kaganov and Ya.M.Chikvashvili.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 275-81 (Jan., 1961).
In Russian.

The theory of spin waves is used to calculate the temperature and frequency dependences of the absorption coefficient at temperatures far below the Curie point. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 1, 200-4 (July, 1961)]

A.Tybulewicz

14171 EXTREMELY LOW LOSS ACOUSTIC RESONANCE IN SINGLE-CRYSTAL GARNET SPHERES.

R.C.LeCraw, E.G.Spencer and E.I.Gordon.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 620-2 (June 1, 1961).

An acoustic resonance was observed at room temperature and at 9.2 Mc/s in single-crystal spheres of yttrium iron garnet with a Q of nearly 10^7, that is, nearly an order of magnitude greater than for any other known material at this temperature and frequency. The reason why the losses were so extremely low is not as yet known. E.F.W.Seymour

14172 CONTRIBUTION TO THE THEORY OF MAGNETO-ACOUSTIC RESONANCE IN METALS.

É.A.Kaner, V.G.Peschanskii and I.A.Privorotskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 214-26 (Jan., 1961).
In Russian.

The resonance absorption of ultrasonic waves in a magnetic field is studied theoretically. In many respects the resonance mechanism is similar to cyclotron resonance, but is related to the spatial rather than temporal periodicity of the field in the metal. The calculations are performed for closed as well as for open electron trajectories. The positions, widths, and heights of the resonance peaks are determined as a function of the frequency, magnetic field, Fermi surface structure, magnetic field orientation and direction of propagation of the sound relative to the crystallographic axes. A sharp angular dependence of the absorption coefficient has been detected. An investigation of the effects under consideration may yield information on the topology and a number of other important characteristics of Fermi surfaces in metals. The results of the experiments are in good agreement with the predictions of the theory. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 147-55 (July, 1961)].

14173 ULTRASONIC ATTENUATION IN TIN SINGLE CRYSTALS AT LOW TEMPERATURES. K.Kamigaki.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1141-4 (June, 1961).

The ultrasonic attenuation coefficient and velocity in the superconducting and the normal states of tin single crystals were measured at temperatures between 1.5° and 4.2°K. It was found that (1) the anisotropy of ultrasonic attenuation in different crystallographic directions exists in the case of comparatively long wavelengths (the product of the mean free path of conduction electrons and wave number of sound waves is less than unity). (2) Also the ratio of longitudinal to shear wave attenuation was found to be larger than that predicted from the free electron model.

14174 ULTRASONIC ATTENUATION IN MAGNETITE AT LOW TEMPERATURES. K.Kamigaki.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1170-4 (June, 1961).

The ultrasonic attenuation coefficients in magnetite crystals were measured over the temperature range of 4.2°-300°K and two kinds of attenuation peaks were observed below the transformation temperature of ionic ordering. The attenuation is attributable to the relaxed electron diffusion between Fe^{2+} and Fe^{3+} ions on the octahedral sites in the ordered lattice of magnetite. The electron diffusion processes are classified into the single electron process and the coupled transition. The activation energy of the former process is determined to be 0.055 eV and the latter 0.36 eV.

14175 FIELD-THEORETIC APPROACH TO THE PROPERTIES OF THE SOLID STATE. G.Baym.

Ann. Phys. (USA), Vol. 14, 1-42 (July, 1961).

The techniques of quantum field theory are used to investigate the thermodynamic ion displacement correlation function — or Green's function of the phonon field — in a crystal and especially in a metal. The structure of thermodynamic Green's functions is outlined and the method for solving for them at finite temperature is fully discussed. The analytic structure of the phonon Green's function is then considered. This function is shown to be bounded and invertible everywhere off the real axis; a spectral form is derived for its inverse. The symmetries imposed by the point group of the crystal are then discussed. Assuming small ionic oscillations, the inverse of the phonon Green's function is found as a linear function of the electronic contribution to the dielectric response function of the metal. This dielectric function is shown to be simply related to the longitudinal part of the conductivity tensor that gives the response of the electrons to the effective electric field in the metal. The assumption of translational invariance then leads to an explicit expression for the phonon Green's function in terms of this conductivity. The deformations in the lattice induced by an arbitrarily time varying external force are calculated in terms of the retarded phonon Green's function. In the static long wavelength limit the phonon Green's function yields the macroscopic elastic constants of the crystal. Their relation to the conductivity is exhibited, and several elastic constants are estimated. The complete phonon spectrum and the lifetimes of the phonon states may be calculated
from this Green's function. A relation between the long wavel
acoustic attenuation in metals and the d.c. conductivity is deri
which is in good agreement with recent experiments. Further
the ions in a metal are shown to have a high-frequency oscilla
along with the electrons, at essentially the electron plasma frequency.

14176 ELECTRON EXCHANGE CORRECTION TO THE PHONON DISPERSION RELATION IN METALS.

O.von Roos.
Phys. Rev. (USA), Vol. 124, No. 1, 71-4 (Oct. 1, 1961).

The statistical theory recently developed (Abstr. 908 of 1
is applied to an investigation of the dispersion relation of sou
waves in metals with special regard to contributions due to
electron exchange. It is found that these contributions are by
means negligible in the long-wavelength limit, contrary to cu
belief. Furthermore it is shown that the temperature depende
of the renormalized sound frequencies is solely mediated by t
temperature dependence of the Fermi-Dirac distribution of th
electrons.

Thermal Properties

14177 THERMODYNAMIC DATA AND VAPOUR PRESSU OF THE MOST IMPORTANT III–V-COMPOUNDS

T.Renner.
Solid-State Electronics (GB), Vol. 1, No. 1, 39-45 (March, 19
In German.

Tables of the thermodynamic properties, such as enthalp
formation, free energy of formation, and entropy, for the most
important III–V-compounds were prepared from data collect
from various sources. Vapour-pressure data of InAs, GaAs
InP are presented.

14178 SPECIFIC HEAT OF SUPERPARAMAGNETIC PARTICLES. J.D.Livingston and C.P.Bean.

J. appl. Phys. (USA), Vol. 32, No. 10, 1964-6 (Oct., 1961).

The specific heat of an assembly of independent superpar
magnetic particles was calculated by the methods of statistica
mechanics. The cases of isotropic particles in an applied fiel
anisotropic particles in the absence of a field were treated.
calculated specific heat is temperature dependent and is of the
order of k per particle at low temperatures. A smaller contri
varying linearly with temperature can also appear thus affecti
the linear temperature coefficient of specific heat usually ass
with the electronic specific heat. Conditions are discussed un
which these effects should be observable.

THERMAL PROPERTIES OF SOME METALS AND ALL
See Abstr. 13006

14179 HEAT CAPACITIES OF TWO MANGANESE SALT H.Forstat and G.O.Taylor.

J. Phys. Soc. Japan, Vol. 16, No. 1, 128-9 (Jan., 1961).

Measurements were made in an adiabatic calorimeter, u
carbon resistance thermometry, on single crystals of monocl
$MnSO_4.4H_2O$ and rhombic $MnHPO_4.3H_2O$. The data curves obt
supported by proton resonance experiments, afford no eviden
the magnetic ordering process usually associated with an anti
magnetic—paramagnetic transition. H.H.H

14180 SPECIFIC HEAT OF SODIUM AT LOW TEMPERA TURES. D.L.Martin.

Phys. Rev. (USA), Vol. 124, No. 2, 438-41 (Oct. 15, 1961).

Specific heat measurements are reported in the temperat
range 0.4° to 1.5°K on two samples of sodium metal. A therm
cycling procedure was used to partly inhibit the martensitic
transformation and thus obtain information on the properties
the two phases of sodium. It is concluded that the electronic
specific heat coefficient (γ) of the b.c.c. phase is probably sli
larger than that of the h.c.p. phase but with 95% confidence th
difference does not exceed 20%. A statistically significant va
(of unknown cause) of the apparent γ of one sample was obser
It is suggested that the wide variation in experimental γ value
reported may be due to this cause rather than to the martensi
transformation.

4181 THERMAL PROPERTIES OF $NaNO_2$.
S.Nomura.

hys. Soc. Japan, Vol. 16, No. 7, 1352-7 (July, 1961).

Specific heat and thermal expansion coefficients of $NaNO_2$ stals were measured from room temperature to 210°C. A contion-type calorimeter was adopted for the measurement of the cific heat and a differential-type dilatometer for the measurement he thermal dilatation. A λ-type anomaly in specific heat was erved near the transition temperature, the transition heat being culated as ~ 285 cal mol^{-1}. The crystal expands in the a and b ection, while it contracts in the c direction with increasing perature, and further the transition is accompanied by abrupt nges in the cell dimensions. Results on thermal dilatation were npared with those obtained from X-ray data. Ferroelectricity aNO_2 is discussed in connection with the results.

4182 THERMODYNAMIC PROPERTIES OF THORIUM DIOXIDE FROM 298 TO 1200°K.
.Victor and T.B.Douglas.

es. Nat. Bur. Stand. (USA), Vol. 65A, No. 2, 105-11 (March-il, 1961).

As a step in developing new standards of heat capacity icable up to very high temperatures, the heat content (enthalpy) orium dioxide, ThO_2, relative to 273°K, was accurately measured en temperatures from 323 to 1173°K. A Bunsen ice calorimeter a drop method were used to make the measurements on two ples of widely different bulk densities. The corresponding heat-acity values for the higher density sample are represented in their uncertainty (estimated to be ±0.3 to 0.5%) by the follow-empirical equation (cal $mole^{-1}$ deg^{-1} at T°K):

$$C_p^0 = 17.057 + 18.06(10^{-4})\ T - 2.5166\ (10^5)/T^2$$

98°K this equation agrees with previously reported low-perature measurements made with an adiabatic calorimeter. ues of heat content, heat capacity, entropy, and Gibb's free rgy function are tabulated from 298.15 to 1200°K.

SPECIFIC HEATS OF SOME CUBIC SUPERCONDUCTING ANIUM–MOLYBDENUM ALLOYS BETWEEN 1.1 AND 4.3°K. Abstr. 13046

4183 SPECIFIC HEAT OF Ti_2O_3.
S.Nomura, T.Kawakubo and T.Yanagi.

hys. Soc. Japan, Vol. 16, No. 4, 706-10 (April, 1961).

A measurement of the specific heat of Ti_2O_3, prepared by the hod of powder metallurgy, was carried out in the temperature ge from 50° to 250° C, under the pressure of 10^{-4} mm Hg. A lified method of measurement by the conduction-type calorimeter adopted, and its reliability of measurement was described in nection with the method of calculation. A broad anomaly of cific heat was observed near 180° C and the amount of anomalous was 36 cal mol^{-1}, which is smaller than Naylor's result (1948). e discussions about the anomaly of specific heat are presented.

4184 DEBYE Θ OF SOME CRYSTALS.
S.K.Joshi and S.S.Mitra.

an J. Phys., Vol. 34, No. 11, 532-4 (Nov., 1960).

The Debye characteristic temperature, Θ, of a number of stals belonging to different symmetry classes was calculated is tabulated. The calculations represent additions to those tained in an earlier publication (Abstr. 915 of 1961). Elastic stants determined at room temperatures were used in the ence of 0°K data. Values of Θ determined from specific heat asurements near 0°K are included for comparison.

P.J.Dean

4185 THERMAL EXPANSION OF SOME ALKALI HALIDES BY X-RAY DIFFRACTION.
P.D.Pathak and N.V.Pandya.

an J. Phys., Vol. 34, No. 9, 416-23 (Sept., 1960).

X-ray data are reported on the thermal expansion of KBr, KI CsBr up to their melting points. The contribution of lattice ects to the thermal expansion is discussed. The applicability of Debye–Grüneisen theory to explain the variation of thermal ansion with temperature is examined. An explanation of the erence in the values observed by the X-ray and the macroscopic hods is given, and the theory is used to obtain a quantitative asure of the Schottky defects.

4186 ELASTIC DEFORMATION AND THERMAL EXPANSION.
R.I.Garber and I.A.Gindin.

tverdogo Tela (USSR), Vol. 3, No. 1, 176-7 (Jan., 1961). ussian.

Using a diatomic model, the thermal expansion coefficient α for a solid subjected to uniaxial deformation or uniform volume extension is found as $\alpha = \alpha_0\ (1 + \beta\epsilon_1)$, where α_0 is the zero stress expansion coefficient, ϵ_1 is the small relative displacement caused by the stress, and $\beta = -\kappa f \gamma/3$, where κ is the compressibility, γ is the Grüneisen coefficient and $f \cong -E$, where E is the elasticity modulus. Values of β are tabulated for eight metals. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 127-8 (July, 1961)].

R.F.S.Hearmon

CONTRIBUTION OF THERMAL LATTICE DEFECTS TO EXPANSION IN PURE METALS. See Abstr. 14289

14187 THE THEORY OF THERMAL CONDUCTIVITY OF DIELECTRICS BELOW THE DEBYE TEMPERATURE.
V.M.Agranovich and Yu.V.Konobeev.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 97-9 (Jan., 1961). In Russian.

The thermal conductivity is calculated assuming that phonons are scattered mainly on isotopic impurities. The resultant value is compared with earlier calculations and shown to give better agreement with the experimental value. [English translation in: Soviet Physics — Solid State (USA) Vol. 3, No. 1, 71-2 (July, 1961)].

K.G.Major

14188 THERMAL CONDUCTIVITY IN TWO-PHASE ALLOYS.
J.B.Schroeder.

J. appl. Phys. (USA), Vol. 32, No. 9, 1798-9 (Sept., 1961).

An analysis of the effect on the thermal conductivity of bismuth telluride of the existence of circulating electric currents arising from the Seebeck e.m.f. between adjacent grains of dissimilar material. It is shown that it is small if the proportion by volume of the minor phase is less than 10%. The presence of a second phase may produce spurious effects through mechanisms other than the Seebeck effect. A lamellar grain structure is assumed.

A.E.Kay

14189 THE TRANSFER OF HEAT BY THE BIPOLAR DIFFUSION OF CURRENT CARRIERS IN LEAD TELLURIDE AND SELENIDE.
E.D.Devyatkova, A.V.Petrov and I.A.Smirnov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1338-41 (May, 1961). In Russian.

The thermal conductivity of specimens of PbTe and PbSe with various impurity concentrations (from 3.3×10^{17} cm^{-3} to 1.2×10^{19} cm^{-3}) was measured in the temperature range 90-800°K. It is shown that the deviation of the lattice conductivity from $\kappa \sim 1/T$ can be explained quantitatively by the additional transfer of heat because of the bipolar diffusion of the current carriers. [English translation in: Soviet Physics—Solid State (USA)].

D.J.Huntley

14190 EFFECT OF THE PRECIPITATION OF DISSOLVED $MnCl_2$ ON THE LOW-TEMPERATURE THERMAL CONDUCTIVITY OF NaCl.
M.V.Klein.

Phys. Rev. (USA), Vol. 123, No. 6, 1977-85 (Sept. 15, 1961).

Low-temperature thermal conductivity measurements were made on NaCl crystals doped with 10^{-4} mole fraction $MnCl_2$. The manganese ions were first quenched into approximate solid solution and then allowed to age at room temperature. Approximate kinetics of the precipitation that resulted were measured by electron spin resonance. There was surprisingly little change in the conductivity during ageing; in particular a low-temperature decrease did not appear. The conclusion was that the presence of clusters cannot be invoked to explain the greater than Rayleigh scattering cross-section often observed with point defects at low temperatures. The small conducitivity changes that did result were: (1) a depression at temperatures near that of the conductivity maximum, and (2) a gradual rise at higher temperatures towards the values obtained with an undoped crystal. These changes were most rapid near the end of the clustering process and suggest a change in the nature of the precipitate at this stage.

14191 THERMAL CONDUCTIVITY OF UO_2 IMPROVES AT HIGH TEMPERATURES.
J.L.Bates.

Nucleonics (USA), Vol. 19, No. 6, 83-7 (June, 1961).

Existing measurements show the conductivity of UO_2 falls with increasing temperature up to 1100°C as would be expected from the reduction of lattice conductivity. It is postulated that at higher temperatures radiant transfer in the infrared becomes important and an expression for the total conductivity is derived showing that it is at a minimum at 1400°C and rises to near its room temperature value at the melting point. This data is important for the design of reactor fuel elements and evidence from examination of irradiated UO_2 specimens supports the new values of conductivity.

R.D.Smith

14192 THERMAL CONDUCTIVITY CHANGES OF $ZnSO_4 \cdot 7H_2O$ BELOW 10°K. B.Sujak.
Acta phys. Polon. (Poland), Vol. 20, No. 2, 167-74 (1961).

Preliminary results have shown, that treatments with water and the presence of acetone vapour in the gas atmosphere in which the single crystal specimens of $ZnSO_4.7H_2O$ were stored at room temperature, influenced their thermal conductivity measured at low temperatures below 10°K. The water increased but acetone vapour reduced the thermal conductivity below that temperature. The thermal conductivity values above 10°K always remained unaffected. Reductions of the initial thermal conductivity of about 50% due to acetone vapour could be observed at 3.5°K. The observed phenomena are thought to be due to changes of perfection of the specimens used, as a result of adsorption and diffusion of acetone and water molecules from the into the specimens which lead to changes in stoichiometric composition of the specimens.

14193 THERMODYNAMIC PROPERTIES OF NONSTOICHIOMETRIC URANIA—ZIRCONIA SOLID SOLUTIONS.
S.Aronson and J.C.Clayton.
J. chem. Phys. (USA), Vol. 35, No. 3, 1055-8 (Sept., 1961).

Thermodynamic information was obtained, at temperatures in the neighbourhood of 1000°C, on nonstoichiometric urania—zirconia solid solutions, $U_yZr_{1-y}O_{2+x}$, with y values of 0.90, 0.80 and 0.70 and x values between 0.04 and 0.17. A solid-state electrochemical technique was used. Partial molar free energies, entropies, and enthalpies of solution of oxygen in the solid were calculated. The results are compared with results previously obtained on non-stoichiometric urania—thoria solid solutions.

14194 INFLUENCE OF TEMPERATURE ON INTEGRATED INTENSITY OF (200) REFLECTION OF PURE Al.
K.Toman.
Czech. J. Phys., Vol. 11, No. 3, 186-92 (1961).

The temperature dependence of the intensity and reflecting range of the (200) reflection of X-rays on an aluminium crystal exhibiting strong primary extinction was studied. It was found that the observed temperature dependence cannot be even approximately expressed by the Debye-Waller factor. The reversible change in the system of imperfections in the crystal is suggested and discussed as a mechanism qualitatively explaining the observed phenomena.

ELECTRON STATES

14195 MATHEMATICAL FOUNDATIONS OF THE QUANTUM-MECHANICAL ELECTRON THEORY IN AN INFINITE CRYSTAL LATTICE. O.Tamaschke.
Ann. Phys. (Germany), Vol. 8, No. 1-2, 76-98 (1961). In German.

The theory of electrons in a periodic lattice is presented in a rigorous way by setting up a mathematical model, based on a non-separable Hilbert space, as a basis of the usual quantum mechanical description in terms of separable Hilbert spaces.

L.Pincherle

14196 THE USE OF THE DAMPING THEORY IN THE CALCULATION OF TRANSPORT COEFFICIENTS.
M.I.Klinger.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3092-3105 (Dec., 1960).
In Russian.

The theory of damping proposed by van Hove (Abstr. 7706 of 1955) is used to calculate the transport coefficients in (and out of) weak magnetic fields. An explicit expression is obtained for the transport coefficients in the extreme case of weak interaction of carriers with their scatterers. In the case of elastic anisotropic scattering, formulae are obtained for magnetoelectric, thermomagnetic, magneto-optical and other effects. [English translation in: Soviet Physics—Solid state (USA), Vol. 2, No. 12, 2747-60 (June, 1961)].

A.Tybulewicz

14197 PHENOMENOLOGICAL INVESTIGATION OF POLAR CRYSTALS.
M.Sh.Hiterman and Ye.A.Turov.
Ukrayin. fiz. Zh. (USSR), Vol. 41, No. 4, 443-50 (1959).
In Ukrainian.

The Hamiltonian is investigated phenomenologically for an electron system interacting with an elastic polar medium. An
pression is obtained for the Hamiltonian in the second quantiz
representation, taking into consideration crystal point symme
The short-range forces are analysed in a general form, and t
results compared with Pekar's theory of polarons.

14198 ELECTRON SCATTERING IN A CRYSTAL LATTI
T.H.Dupree.
Ann. Phys. (USA), Vol. 15, No. 1, 63-78 (July, 1961).

For some types of crystals it is permissible to assume t
within a spherical region surrounding each ion the potential is
spherically symmetric and that in the innerspace between thes
spherical regions the potential is constant. Schrödinger's equ
is solved for such a potential distribution in which the spheric
potential wells are not all alike. Both propagating and nonpro
ing solutions are considered. An asymptotic evaluation of the
scattered by an impurity ion is carried out. From this, a calc
of residual resistance in alkali metal alloys is obtained.

14199 SCATTERING OF ELECTRONS BY THE THERMA
MOTION OF IMPURITY IONS. II. S.Koshino.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1049-54 (Nov., 19

For Pt I, see Abstr. 9992 of 1961. The change of electric
resistance of dilute alloys due to the thermal motion of impuri
ions at low temperatures is calculated using a variational met
The resistance change is found to depend on T^2 at the low-tem
ture limit and its magnitude is larger than that of the normal
scattering resistance when the temperature is sufficiently low

14200 APPROXIMATE WAVE-FUNCTIONS OF FREE IO
AND OF IONS IN A CRYSTAL.
M.I.Petrashen', I.V.Abarenkov and N.N.Kristofel'.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 527-9 (Oct., 1960).
In Russian.

Describes a simple method of calculating approximate on
electron functions of a "central ion" in an ionic crystal. The
electron functions of a free "central ion" are assumed to be k
They are then modified by allowing for the effect of other ions
lattice, regarded as a set of geometrical points. The new func
are known as crystalline one-electron functions and they can b
used in the zeroth approximation of the perturbation theory.
[English translation in: Optics and Spectrosc. (USA), Vol. 9, N
276-7 (Oct., 1960)]. A.Tybu

14201 THE BASIS OF BAND THEORY.
Yu.M.Butusov and M.V.Kopȳtina.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 395-7 (Feb., 1961).
In Russian.

The authors discuss the neglect of the electron interactio
potential in band theory. They use the concept of the model op
tor for the wave-functions and show that this also connects the
interactions with those in the model. It is shown that there is
independent particle representation and a relation between the
quasi-particle wave-functions and the electron wave-functions
derived. [English translation in: Soviet Physics - Solid State
Vol. 3, No. 2, 288-9 (Aug., 1961)]. M.G.Pri

14202 THE EFFECT OF LONG-RANGE ORDER ON ENE
BANDS IN BINARY ALLOYS. A.Corciovei and D.G
Acta phys. Polon. (Poland), Vol. 20, No. 3, 197-211 (1961).

Perturbation theory is applied to the energy bands of a pa
disordered alloy, starting from a perfectly ordered one for wh
the energy bands are assumed to be known, and proceeding to
consider the perturbation produced by the disorder of the allo
to compute the corrections to the energy levels by perturbatio
theory in the first and in the second approximation. The width
certain forbidden bands on Brillouin surfaces was found to dec
as the long-range-order parameter, R, diminishes. At complet
disorder the respective forbidden bands vanish completely. T
electron energy is investigated as a function of the propagatio
vector in the neighbourhood of the forbidden band.

14203 THE MODIFICATION OF ELECTRON ENERGY LE
BY IMPURITY ATOMS. R.Klauder.
Ann. Phys. (USA), Vol. 14, No. 1, 43-76 (July, 1961).

The influence of localized impurities in solids may be
represented either by (1) the effect of randomly distributed
classical scattering centres for which only averaged quantitie
meaningful or (2) the effect of an equivalent quantum descript

h incorporates both the random character and the process of aging. Adopting the latter viewpoint, diagrammatic perturba- methods familiar in field theory and many-body studies are with. As an application of this formalism, various approxima- s, all of infinite order in the perturbation, are derived for the age density of states in an idealized solid for which the effects e impurities prevail and the periodic lattice may be neglected. results of the approximations are compared with the exact ılts obtained by Frisch and Lloyd for a special model in which impurity potential may be represented as an attractive one- ensional delta-function. One of the approximations discussed direct analogue of the Brueckner model, and for the delta- tion potential example this approximation can be solved tly. In the case of a high density of impurities, our solutions onstrate the well-known value of propagator modification, while, a low density of impurities, several solutions exhibit an impur- band that is isolated from the conduction band. Finally, the rage wave function is discussed. Two distinct rules for pairing efunction with impurity sites are analyzed in detail: one rule ricts the wave and its derivative to have specified initial values demands neither normalizability nor singlevaluedness; the r rule requires that every acceptable wave be an eigenvector se phase, relative to the other waves, is selected in a definite ner. Differential equations are presented which are obeyed by two differently defined average wave functions in the case of a -dimensional delta-function potential.

14204 GROUP THEORY TREATMENT OF THE SPLITTING OF CRYSTAL LEVELS BY THE INTERACTION OF UIVALENT LATTICE PARTICLES. K.Schulz.
Phys. (Germany), Vol. 163, No. 3, 293-308 (1961). In German.

First an analysis of the Hamiltonians related to Bethe's crystal els and to the energy levels of the whole crystal is given. Then splitting of Bethe's levels by the interaction between the elect- s of equivalent lattice particles is described in the group ring tor group splitting, Davydov splitting). By this Winston's rule this splitting is deduced from a new group-theoretical point of w. Bethe's levels degenerated according to time reversal ametry are considered, and spin is treated.

14205 THE SPATIAL DISTRIBUTION OF ELECTRONS IN THE TIGHT BINDING AND NEARLY-FREE-ELECTRON PROXIMATIONS. G.Gousseland and G.Leman.
Phys. Radium (France), Vol. 22, No. 2, 65-75 (Feb., 1961). French.

Discusses crystalline structures in detail. For one atom per t cell and in tight binding the electron density of a full band is sum of the atomic densities. The bottom of the band has a nding" character: the electron density increases along the inter- mic bonds; the top of the band is "antibinding" with a weakening he bonds. For nearly free electrons, and still one atom per unit l, all of the lowest band is "binding". The example of the mond-type cubic structure shows that in tight binding, bands are ally binding (or antibinding) only if hybridization occurs, but for free ctrons the lowest band is always totally binding.

14206 CALCULATION OF THE ENERGY CHANGE IN A SYSTEM OF ELECTRONS IN A LATTICE WHEN FECTS ARE FORMED. V.I.Osherov.
eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 152-5 (Jan., 1961). Russian.

A system of non-interacting electrons in a lattice is considered. a single-band approximation the changes of energy and thermal acity of this system when defects are formed are calculated. glish translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, -6 (July, 1961)].

14207 NUCLEAR QUADRUPOLE INTERACTION IN PURE METALS. T.P.Das and M.Pomerantz.
ys. Rev. (USA), Vol. 123, No. 6, 2070-6 (Sept. 15, 1961).

Calculations of the ionic part of the electric field gradient he nuclei of certain metals are combined with available experi- ntal data to obtain information about the electronic structures of metals, or estimates of nuclear quadrupole moments. The tals considered are Be, Sc, Re, La, Mg, Co, Zn, and Cd, which e the hexagonal close-packed structure, and indium, which has entred tetragonal structure. Some comparison is made with er information about the shapes of the Fermi surfaces and a tinent experiment on Zn is suggested.

14208 THE ELECTRONIC ENERGY BANDS OF THE ALKALI METALS AND METALLIC BERYLLIUM. J.F.Cornwell.
Proc. Roy. Soc. A (GB), Vol. 261, 551-64 (May 23, 1961).

The applicability of various electronic energy band interpolation schemes to the alkali metals and metallic beryllium is discussed. An "l-dependent" pseudo-potential method using only a very small number of plane waves in the expansion of the valence electron wavefunctions is then applied to these metals. The density of states curves and the Fermi surfaces are calculated. It is found that for lithium the Fermi surface may touch the Brillouin zone boundaries. The calculated and observed low-temperature electronic specific heat coefficients and valence bandwidths are compared.

14209 EFFECT OF PRESSURE ON THE ENERGY GAP OF Bi_2Te_3. Che-Yu Li, A.L.Ruoff and C.W.Spencer.
J. appl. Phys. (USA), Vol. 32, No. 9, 1733-5 (Sept., 1961).

The effect of hydrostatic pressure on the energy gap of Bi_2Te_3 was investigated in the pressure range 30 000 atm. From resistivity measurements as a function of temperature and pressure, it was determined that the energy gap decreases from 0.171 eV at one atmosphere to 0.104 eV at 30 000 atm, corresponding to $\partial E_g(0)/\partial p = -2 \times 10^{-6}$ ev/atm.

14210 ENERGY LEVELS IN THE FORBIDDEN GAP OF INSULATING DIAMONDS.
R.R.Urlau, H.J.Logie and F.R.N.Nabarro.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 256-74 (Aug., 1961).

Two type I diamonds and one type IIa were examined for the following properties: counting of beta-particles in the dark, counting under space charge, effect of monochromatic illumination on counting under an applied field and under space charge, change of total charge while counting and while conducting, and photoconductivity. On the basis of these observations and of the known optical absorption of diamonds of these types a preliminary level scheme is proposed as follows:

(i) A level 0.94 eV above the valence band. This level provides traps for holes, and is normally filled, but gives rise to photoconductivity after exposure to electron bombardment or irradiation with energetic ultraviolet light.

(ii) A level 1.6 eV above the valence band. This level also provides traps for holes and is tentatively identified with the Kaiser—Bond nitrogen level.

(iii) A level 3.3 eV above the valence band. This level is partly filled and provides traps for electrons. It can give rise to either n- or p-type photoconductivity.

14211 THE EFFECTIVE NUMBER OF ELECTRONS IN THE π BAND OF GRAPHITE. T.E.Peacock.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1214-15 (June, 1961).

Using the results of the SCF calculation (Abstr. 4277 of 1960) the number of free electrons and positive holes at room temperature has been estimated. This is found to be 1.1×10^{-5} per atom.

T.E.Peacock

14212 THE SURFACE STATES OF A SIMPLE CRYSTAL MODEL. T.B.Grimley and B.W.Holland.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 217-24 (Aug., 1961).

The energies of surface states as functions of a parameter γ, which measures the electron affinity of a surface atom relative to an atom in the interior of the crystal, are calculated for a one-dimensional δ-well chain. The treatment is extended to a three-dimensional simple cubic lattice by using a modified free-electron network model. Depending on γ, surface bands can exist in the energy gaps between the volume bands, or a surface band may overlap and lose any number of states to the volume bands below it. Only the lowest volume band, derived from the single bound state of the isolated δ-well, can give rise to a surface band of lower energy.

14213 THE FERMI SURFACES OF THE NOBLE METALS. J.F.Cornwell.
Phil. Mag. (GB), Vol. 6, 727-33 (June, 1961).

The energy-band structure of the noble metals is calculated using a plane-wave pseudo-potential method, and the properties of the Fermi surfaces so obtained are compared with those deduced from experimental observations.

14214 CALCULATED SHAPE OF THE FERMI SURFACE OF COPPER. B.Segall.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 154-5 (Sept. 1, 1961).

The results of the calculation described by Segall and Krieger

[Bull.Amer. Phys. Soc., Vol. 6, 10 (1961)] and Segall [Bull.Amer. Phys. Soc., Vol. 6, 231 (1961)] are discussed. This calculation gives a Fermi surface that is consistent with that proposed by Pippard (Abstr. 2651 of 1958), but distortions of the "belly" from the spherical are obtained, and these are found to be comparable with those predicted by magnetoacoustic effect measurements. J.F.Cornwell

14215

TOPOLOGY OF THE FERMI SURFACE OF COPPER.

G.A.Burdick.

Phys. Rev. Letters (USA), Vol. 7, No. 5, 156-7 (Sept. 1, 1961).

The energy levels at the equivalent of 2048 points in the first Brillouin zone of copper were calculated by means of the augmented plane wave method, using the potential obtained by Chodorow. The Fermi surface deduced from these is in close agreement with that obtained theoretically by Segall (see previous abstract) and that deduced from experiment by Pippard (Abstr. 2651 of 1958). Comparison is made with the results of magnetoacoustic effect measurements. J.F.Cornwall

14216

FERMI MOMENTUM FOR FREE ELECTRON METALS PERTURBED BY LOCALIZED IMPERFECTIONS.

A.Sugiyama.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1327-36 (July, 1961).

The Fermi momentum k_m and the interior density ρ_i are calculated for free electron metals perturbed by localized imperfections, and the Thomas–Fermi relation

$$\rho_i = k_m^3/3\pi^2$$

is verified up to a higher order. Then it is shown that the Friedel theorem (Abstr. 3758 of 1952) can be based on the above relation. When the Fermi momentum k_m is expressed in terms of the phase shift η of the free electron wavefunction, the charge neutrality condition in the interior leads to the Friedel sum rule for the case of the plane surface as well as of the point imperfection.

14217

SELECTION RULES CONNECTING DIFFERENT POINTS IN THE BRILLOUIN ZONE.

M.Lax and J.J.Hopfield.

Phys. Rev. (USA), Vol. 124, No. 1, 115-23 (Oct. 1, 1961).

Selection rules for indirect radiative transitions and for intervalley scattering are investigated for Ge and Si. Comparison with experimental results of Haynes and of Benoit à la Guillaume supports (1) the present picture of the band structure of Ge with a conduction band minimum at the zone boundary, (2) the assignment of $L_{2'}$ as the symmetry of the LA phonon at the zone boundary in the [111] direction. The absence of the LA phonon in the Haynes radiative emission experiment still requires explanation. To obtain the required selection rules the authors take the product of two irreducible representations i and j that belong to different wave vectors $\vec{k}$ and $\vec{k}'$. The resulting character product is expressed in a form appropriate to a third group $G_{k''}$ at $\vec{k}'' = k + \vec{k}'$. If the elements of $G_{k''}$ are applied to $\vec{k}$ to generate a star and N(C) is the number of points of the star invariant (or equivalent) under any element R in the class C(of $G_{k''}$) then the character product is $N(C)\langle\chi^i(R)\chi^j(R)\rangle$ i.e., N(C) times the product of the characters averaged over those R in C which belong to $G_{k'}$ and $G_{k''}$ (i.e., those whose characters can be found in the tables at $\vec{k}'$ and $\vec{k}''$).

14218

STATISTICAL PROPERTIES OF THE ELECTRON SYSTEM OF FERROMAGNETIC TRANSITION METALS.

S.V.Vonsovskii and Yu.A.Izyumov.

Fiz. Metallov i Metallovedenie (USSR), Vol.10, No. 3, 321-34 (Sept., 1960). In Russian.

The method of advanced and retarded Green's functions is used to study the properties of the electron system of ferromagnetic metals in the transition and rare earth groups. It is shown that a system which comprises conduction electrons, interacting with electrons of the inner, localized, unfilled, and spin-unsaturated levels of the electron shells of the ions in a crystal of a transition group element, has elementary excitations of both the Fermi (conduction electron) and Bose (spin-wave) types. The existence of two energy branches of the Bose type is established. Under the conditions of zero energy quasi-impulse, one of these branches has zero energy and the energy of the other branch is of the order of the exchange interaction between the conduction electrons and electrons of the inner levels, this situation existing at all temperatures at which the metal retains its ferromagnetic properties. The attenuation frequency of the spin waves, dependent on collisions with the conduction electrons, is determined. M.H.Sloboda

14219

ELECTRON DISTRIBUTION IN Cu_2O CRYSTAL.

T.Suzuki.

J. Phys. Soc. Japan, Vol. 16, No. 3, 501-9 (March, 1961).

The atomic scattering factor and the electron distribution studied by X-ray diffractometry in order to determine the ele state of O in crystalline Cu_2O. The intensity measurements w performed within an experimental error of about 1 to 3%. The atomic scattering factor of O was determined with reference t scattering factor of Cu, and was compared with theoretical val of O^{2-}, O and O^{2+}. The observed value corresponds best to th scattering factor of O^{2-}. However, a small deviation from the ideally ionic O^{2-} state, for example the state of $O^{1.85-}$, is poss which may be expected from the positive hole model for the Cu crystal. The electron distribution in some special planes of th cell of the crystal was determined by three dimensional Fouri synthesis. The electron distributions were found to be almost spherical around each atom except for the overlapping of the el cloud in the region between neighbouring Cu and O atoms.

14220

THE DISTRIBUTION OF ELECTRONS IN THE PROCESS OF IMPACT IONIZATION.

M.Miasek.

Acta phys. Polon. (Poland), Vol. 20, No. 1, 43-58 (1961).

The electron impact ionization plays an important role in various processes occurring in solid insulators and semicondu The probability function of occupying the states with definite e in the conduction band after an ionization is calculated. The v band is assumed of finite width. Several cases of the primary and of the effective mass of the valence band are examined.

14221

FAST-RISETIME EXCITATION SCHEME TO ACH NONEQUILIBRIUM AND AMPLIFYING CARRIER DISTRIBUTIONS.

G.C.Dousmanis.

J. appl. Phys. (USA), Vol. 32, No. 10, 2005-7 (Oct., 1961).

A technique is suggested for creating anisotropic and emi carrier distributions in semiconductors or other crystals at l temperatures. As an example, application of the technique in re-entrant (negative-mass) regions of heavy holes in germani and silicon, in conjunction with cyclotron resonance using circ polarized microwaves, is discussed. These distributions are expected to be short-lived (of order 0.2 to 5 nsec), but more aniso than those so far obtained in these regions by steady-state opt excitation alone. The non-equilibrium distributions would be created by excitations (pulsing, for example) with rise-time s than the carrier-phonon scattering time. Recently, the increa purity of materials and speed of electronic instruments have approached the theoretical requirements of this method.

14222

PRESENT STATE OF THE EXCITON PROBLEM.

M.Balkanski.

J. Phys. Radium (France), Vol. 22, No. 2, 113-17 (Feb., 1961) In French.

Critical review of the general ideas on excitons, and thei recent evolution. Special attention is given to the case of sem conductors of the CdS, Si and Ge types.

14223

A NOTE ON EXCITON MULTIPLICITIES.

R.S.Knox.

Progr. theor. Phys. (Japan), Vol. 24, No. 4, 909-10 (Oct., 196

Takeuti recently concluded, from a theoretical examinati the energy states of the exciton (Abstr. 946 of 1961), that thes always obey Hund's rule. Knox has observed experimentally, solid argon, an exciton singlet state which lies lower than the state. In this note is shown how the possibility of such a viola Hund's rule follows from the use of multiplicity-dependent Wa functions to describe the energy states of the exciton. P.

14224

THE THEORY OF THE EDGE OF EXCITON ABSC TION BANDS.

V.M.Agranovich and Yu.V.Konobee

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 360-9 (Feb., 1961). In Russian.

An account of retardation effects in the interaction betwe electrons in a crystal leads to the appearance of new element excitations - polaritons - instead of excitons and transverse p It is shown that this gives a long wavelength absorption which positive exciton effective mass and large oscillator powers, d mines the shape of the long wavelength edge of the exciton abs bands. [English translation in: Soviet Physics - Solid State (Vol. 3, No. 2, 260-8 (Aug., 1961)]. M.G.Pr

225 THE ENERGY OF EXCITON ABSORPTION IN THE α-BAND REGION OF ALKALI-HALIDE CRYSTALS.

sertsvadze.
verdogo Tela (USSR), Vol. 3, No. 2, 336-41 (Feb., 1961).
ssian.

n expression for the difference between the energies of ation of a free exciton and an exciton near a halogen cy (Abstr. 3821 of 1957) is generalized for any distance en the exciton and the vacancy. The same energy difference rived for a free exciton and an exciton near an alkali-metal cy. The theoretical results are compared with experiment. ish translation in: Soviet Physics - Solid State (USA), Vol. 3, , 241-4 (Aug., 1961)]. S.Chomet

226 THE INFLUENCE OF ELECTRONIC POLARIZATION ON EXCITONS IN ALKALI HALIDE CRYSTALS.

ller.
turforsch. (Germany), Vol. 16a, No. 4, 401-10 (April, 1961).
rman.

he continuous approximation is not applicable to excitons in halides where the hole—electron distance is less than that to bouring halogen ions. The Toyozawa—Haken—Schottky model d to determine the effect of electron polarization of the n due to the lattice interaction. The effect is negligible if nd electron are on the same halogen ion. For larger distances ll value of the optical dielectric constant must be assumed in oulomb interaction. For large distances in NaCl the polarization nergy is -2.8 eV. The model used is so exact that it needs orentz correction to the optical dielectric constant.

G.F.J.Garlick

227 EXCITON DIFFUSION IN NAPHTHALENE CRYSTALS.

A.A.Kazzaz and A.B.Zahlan.
. Rev. (USA), Vol. 124, No. 1, 90-5 (Oct. 1, 1961).

xciton capture by anthracene in naphthalene crystals is ed as a function of impurity concentration (4×10^{-8} to 4.8×10^{-3}), erature, annealing, and wavelength of exciting radiation. It own that surface, incoherent, and possibly coherent free ons participate in these excitonic processes. A method for ling molecular crystals is described. Some observations on mperature dependence of these processes are reported.

228 THEORY OF POLARON MOBILITY.

Y.Ōsaka.
. theor. Phys. (Japan), Vol. 25, No. 4, 517-36 (April, 1961).

he polaron mobility is calculated by making use of the general y of electrical conductivity. The states determined by Feynman's action are taken as the unperturbed states and the difference en the true action and the trial action is treated as a perturba- Numerical values of the polaron mobility at very low tempera- are given and are discussed in comparison with the results ned by Schultz (Abstr. 2812 of 1960) and by Morita (Abstr. 5733 55).

229 POLARON RETARDATION.

Yu.I.Horkun.
yin. fiz. Zh. (USSR), Vol. 3, No. 3, 289-96 (1958). In Ukrainian.

Using the classical treatment of ion motion and taking into unt the anharmonicity of ion oscillations, a calculation is of the average energy lost in unit time by a fast polaron. The lt embraces as a limiting case Pekar's result for low polaron ities (1951) and that of Tolpygo and Uritskii for high velocities tr. 8472 of 1956). It differs from both in the intermediate n.

4230 COLLECTIVE OSCILLATIONS IN AN ELECTRON GAS OF METALLIC DENSITY. THE CORRELATION RGY. I.

J.Śledzik.
phys. Polon. (Poland), Vol. 20, No. 1, 3-22 (1961).

The role of the subsidiary conditions in the Bohm and Pines ry of an electron gas is analysed anew. It is pointed out that ubsidiary conditions must be formulated in the form of two of operator identities: the first set establishes the Bohm— s operators of subsidiary conditions, and the second — the mutators of the extended Hamiltonian and of the first set. The nded Hamiltonian and the two sets of supplementary conditions proved to be equivalent to the n-electron Schrödinger equation. two sets of subsidiary conditions make it possible, at last retically, to replace a certain number of electronic positions momenta by coordinates and momenta of a longitudinal field ribing the long-range density fluctuations. This problem cannot be solved in practice on account of mathematical difficulties. Therefore it is assumed that a certain number of excited electron—hole pairs and the collective response to them (the rearrangement of charge) may be described by a certain effective longitudinal field introduced by Bohm and Pines. In the theory thus formulated, the total number of degrees of freedom of the system is correct and no subsidiary conditions are required. The Hamiltonian and the ground-state function are the same as in the Bohm—Pines theory, but the number of individual electrons is smaller. The correlation energy obtained is several times smaller than that of Bohm and Pines. The theory proposed is valid within the alkali-metal density range.

14231 COLLECTIVE OSCILLATIONS IN AN ELECTRON GAS OF METALLIC DENSITY. THE CORRELATION ENERGY. II.

J.Śledzik.
Acta phys. Polon. (Poland), Vol. 20, No. 1, 23-42 (1961).

In order to isolate the plasmons in the Hamiltonian derived in Pt I, the canonical transformation to independent plasmon modes is applied. The formula for the correlation energy obtained is nearly the same as that of the Gell-Mann and Brueckner high-density electron gas theory. The absolute value of the constant in the correlation energy is by 4% larger than in the Gell-Mann and Brueckner approach. The second-order energy shift within the Rayleigh—Schrödinger perturbation theory framework is evaluated.

14232 THE USE OF ELECTRON GAS MODIFICATION IN THE EVALUATION OF THE VIBRATION FREQUENCIES AND THE SPECIFIC HEATS OF SODIUM AND POTASSIUM.

B.Dayal and B.Sharan.
Proc. Roy. Soc. A (GB), Vol. 262, 136-44 (June 13, 1961).

Earlier work on the determination of the specific heats of lithium by the use of deLaunay's model is extended to sodium and potassium. A new technique is introduced in which the contributions of the central and the outer parts of the Brillouin zone to C_v are calculated separately from different distribution densities of 8000 and 1000 points per zone, respectively. The agreement between the calculated and the experimental values of C_v is found to be very good except at very low temperatures where the deviations can be ascribed to the presence of phase transformation. The effect of using a finer mesh of points on C_v is examined. In order to get accurate values of C_v the density of points in the central region has to be increased considerably. In the outer region, however, a low density of eight points per zone as in Raman's theory is found to be reasonably satisfactory.

14233 PLASMA FREQUENCIES OF METALS DETERMINED BY OPTICAL CONSTANTS.

U.Furukane, M.Hasikuni and H.Takeyama.
J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 589-96 (Dec., 1960).

A method was proposed to calculate the plasma frequencies of metals from optical constants in the visible and ultraviolet regions. Of several metals, the plasma frequencies obtained by this method were found to be in good agreement with the free-electron plasma frequencies.

14234 ON THE BREADTHS OF ANNIHILATION LINES IN ONE- AND TWO-VALUED [MONOVALENT AND DIVALENT] METALS.

B.Średniawa.
Acta phys. Polon. (Poland), Vol. 20, No. 3, 235-42 (1961).

Stewart's measurements (Abstr. 3616 of 1957) of the breadths of annihilation lines in the process of annihilation of positrons in metals are analysed using the method of the author (Abstr. 11558 of 1960) in the case of 16 monovalent and divalent metals present. In light metals (Li, Be, Na, Mg) positrons are annihilated with conduction electrons only; in heavier metals the contribution of annihilation with electrons of the atomic shells increases gradually. Noble metals have a particular position: in Cu, Ag, and Au the annihilation takes place almost exclusively in the atomic shells.

14235 CYCLOTRON RESONANCE IN ANTIMONY.

W.R.Datars and R.N.Dexter.
Phys. Rev. (USA), Vol. 124, No. 1, 75-80 (Oct. 1, 1961).

Measurements of cyclotron resonance using the trigonal plane in single-crystal antimony were made with linearly and circularly polarized radiation (23.5 kMc/s) in magnetic fields up to 8500 Oe at liquid helium temperatures. The observed oscillations for magnetic field directions parallel to the crystal surface were identified as Azbel'—Kaner resonances (Abstr. 8850 of 1959). The tilted-ellipsoidal Fermi-surface model proposed by Shoenberg

(Abstr. 5913 of 1952) was successfully used to interpret the data. The mass parameters in this model were determined from a combination of present data with some of Shoenberg's de Haas—van Alphen data to be $m_1/m_0 = 0.050$, $m_2/m_0 = 1.03$, $m_3/m_0 = 0.53$, and $|m_4|/m_0 = 0.67$. Analysis of data obtained with circularly polarized radiation suggests that the carriers responsible for these Azbel'—Kaner resonances in antimony are electrons.

14236 MILLIMETER CYCLOTRON RESONANCE EXPERIMENTS IN DIAMOND. C.J.Rauch.

Phys. Rev. Letters (USA), Vol. 7, No. 3, 83-4 (Aug. 1, 1961).

Experiments on type IIb diamonds at 4 mm wavelength and 1-4°K showed two approximately isotropic groups of carriers, thought to be holes, of mass $0.70\,m_0$ and $1.07\,m_0$. R.G.Chambers

14237 CYCLOTRON RESONANCE OVER A WIDE TEMPERATURE RANGE. I. GERMANIUM.

D.M.S.Bagguley, R.A.Stradling and J.S.S.Whiting.

Proc. Roy. Soc. A (GB), Vol. 262, 340-64 (July 18, 1961).

A systematic investigation of cyclotron resonance in germanium was carried out at 8.8 mm wavelength throughout the temperature range 2 to 100°K. Typical expressions for the collision times derived from the line width of the cyclotron resonance in high-purity material are:

light-mass hole $\langle\tau\rangle^{-1} = 0.24 \times 10^{11} + 1.85 \times 10^{8}\,T^{1.5}\ \text{sec}^{-1}$

heavy-mass hole $\langle\tau\rangle^{-1} = 0.15 \times 10^{11} + 1.85 \times 10^{8}\,T^{1.5}\ \text{sec}^{-1}$

electrons $\langle\tau\rangle^{-1} = 0.1 \times 10^{11} + \text{anomaly} + 4 \times 10^{8}\,T^{1.5}\ \text{sec}^{-1}$

Between 20 and 100°K lattice wave scattering is the dominant relaxation process and the collision times derived from the cyclotron resonance are in good agreement with corresponding mobility values. There is an anomaly in the collision time for electrons at about 20°K which can be explained in terms of resonant scattering from a deep attractive potential well. The residual scattering at low temperatures for both holes and electrons appears to arise from neutral scattering sites. The cyclotron resonance from holes in germanium is modified by copper and gold impurities. With large impurity concentrations the heavy-mass hole is almost isotropic. This effect may arise from a motional narrowing of the absorption lines. In highest purity p-type germanium an additional absorption line was observed which arises from a carrier with effective mass $0.27\,m_e$.

14238 CYCLOTRON RESONANCE OVER A WIDE TEMPERATURE RANGE. II. SILICON.

D.M.S.Bagguley, R.A.Stradling and J.S.S.Whiting.

Proc. Roy. Soc. A (GB), Vol. 262, 365-78 (July 18, 1961).

A systematic investigation of cyclotron resonance in silicon was carried out at 8.8 mm wavelength throughout the temperature range 2 to 120°K. Typical expressions for the reciprocal collision times derived from the width of the cyclotron resonance lines in high purity material are:

light- and heavy-mass hole $\langle\tau\rangle^{-1} = 0.15 \times 10^{11} + 6 \times 10^{7}\,T^{2}\ \text{sec}^{-1}$

electrons $\langle\tau\rangle^{-1} = 0.1 \times 10^{11} + \text{anomaly} + 2.9 \times 10^{8}\,T^{1.5}\ \text{sec}^{-1}$

The acoustic lattice wave scattering is in good agreement with the corresponding mobility data, but measurements with samples having a range of impurity concentrations indicate that ionized impurity scattering does not contribute significantly to the cyclotron line width even when it has a very marked effect upon the mobility. There is an anomaly in the collision time for electrons at about 50°K which can be explained in terms of resonant scattering from a deep attractive potential well. This anomaly is very similar to that found previously in germanium. The magnitude of the anomaly is greater in samples containing large concentrations of oxygen but it is not directly related to the total number of oxygen impurities. At low temperatures the residual scattering for both holes and electrons appears to arise from neutral scattering sites. These measurements do not indicate any temperature dependence in the effective mass parameters for holes up to 50°K and for electrons up to 100°K. There is, however, a small discrepancy between the present results and the previously quoted values for the electron effective mass parameter in the ⟨100⟩ direction.

14239 ENERGY SPECTRA OF ELECTRONS AT DIFFERENT POINTS IN THE IRRADIATED MEDIUM. G.A.Volkov.

Fiz tverdogo Tela (USSR), Vol. 3, No. 2, 354-9 (Feb., 1961).

In Russian.

A method for determining the electron spectrum in a β-irradiated medium is presented. Both the scattering and the energy loss
of the electrons, due to ionization and excitation of the medin
are considered. The resulting equation is solved by decomp
into polyomials, solving these using an electronic computer n
presenting graphically the $J/(J_{max}-\eta)$ relationship for differ
of ξ, where J is the electrons distribution function, ξ the po
of an electron on the z axis in r_o units $(-1 \leq \xi \leq 1)$, η the pa
electron from the source to z in r_o units, and r_o is the maxi
possible path of an electron with the maximum energy. The
ular case of a flat Ca^{45} source and an organic glass medium
discussed; J_{max} is taken as unity for $\xi = 0.15$. [English tra
in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 255-9 (A
1961)]. A

14240 ANGULAR DISTRIBUTION OF ELECTRONS SUF ING CHARACTERISTIC ENERGY LOSS IN PASS THROUGH METAL FILMS. H.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 5, 912-16 (May, 1961).

The distribution in energy and angle of 20-25 kV electr
scattered by Al, Ag and Au evaporated films was measured
an electron velocity analyser of Möllenstedt type. The ener
resolution is about 5×10^{-5}, and the angular resolution bett
than 5×10^{-4} radian. The angular distribution of the charac
energy loss was compared with Ferrell's calculation. (Abst
of 1956). The comparison shows that the experimental resu
consistent with a simple Bohm—Pines' approach provided th
correction is made for finite resolution of both energy and a

14241 CHARACTERISTIC ENERGY LOSSES OF ELEC IN CADMIUM, TELLURIUM AND SELENIUM.

F.Pradel and C.Gout.

C.R. Acad. Sci. (France), Vol. 252, No. 17, 2534-6 (April 24,

In French.

Characteristic energy loss spectra of 20 keV electrons
evaporated films of Cd, Te and Se are presented. The Cd sp
contains a fine line at 10 eV, which is in good agreement wit
calculated value of the plasmon energy. The association of t
line with a plasma interaction remains open, however, since
appreciable variation of the spectrum with the scattering ang
observed over a range 0 to 3°. No lines were observed which
be attributed to multiple plasmon excitation, in contrast to th
spectra exhibited by aluminium. No discontinuities were obs
in the optical transparency of Cd between 8 and 27 eV. Prol
exposure to the electron beam resulted in the disappearance
10 eV line, leaving a weak line at 5 eV and a strong line at
These results are attributed to oxidation. The spectra obtai
for Te and Se are interpreted in terms of both plasmon excit
and transistions of single electrons between the d shells and
conduction bands. The optical absorption spectra reveal pea
near to the characteristic energy losses which are attributed
latter effect. P

14242 RIGOROUS DYNAMIC THEORY OF THE COHER PROPAGATION OF ELECTRONS THROUGH AN ABSORBING CRYSTALLINE PLATE. M.Tournarie.

C. R. Acad. Sci. (France), Vol. 252, No. 19, 2862-4 (May 8,

In French.

Starting from the Schrödinger equation, the problem is
ously solved using a mixed lattice representation - direct la
normal to the faces of the plate and reciprocal lattice along
remaining axes. The result differs markedly from that pred
by earlier approximate calculations.

A.E.I. Research Labo

14243 INELASTIC SCATTERING OF CONDUCTION EL TRONS IN DILUTE SILVER—MANGANESE ALL LOW TEMPERATURES. M.S.R.Chari.

Nature (GB), Vol. 190, 994 (June 10, 1961).

An extension of the analysis in Abstr. 11257 of 1961 of t
experiments on thermal and electrical resistivities, reporte
Abstr. 6021 of 1960, indicates that inelastic impurity scatter
makes a large contribution to the electronic thermal resisti
only a small one to the electrical resistivity, causing the an
behaviour of the electronic Lorenz parameter. J.

EXPERIMENTAL STUDIES ON ELECTRONIC TRAPPIN PROCESSES ASSOCIATED WITH DISLOCATION LINES IN ALKALI HALIDE CRYSTALS. See Abstr. 14271

14

THE PERTURBATIONS IN A METAL BY TWO IMPURITY [ATOMS].

B.Caroli.

s. Radium (France), Vol. 22, No. 6, 356-8 (June, 1961).
nch.

ıe perturbations in the electron density of a metal by two ty atoms are studied. On a schematic model using one sional free electrons scattered by two δ potential wells, the oscillations produced by the two impurities are analysed. re shown to be the sum of the charge oscillations due to each wells scattering independently, plus correction terms which higher order of perturbation than the oscillations due to ndent wells.

45

ON "SCREENED IMPURITY POTENTIALS IN METALS".

R.J.Harrison and A.Paskin.

s. Soc. Japan, Vol. 15, No. 10, 1902 (Oct., 1960).

esults of the numerical integration of an expression due to oto for the Fourier transform of the screened impurity ial are given in the form of radial charge density, using data pper. The result is compared with the Thomas—Fermi charge y and the differences are discussed. H.Mykura

DEFECT PROPERTIES

:46

SELF-CONSISTENT PERTURBATION TREATMENT OF IMPURITIES AND IMPERFECTIONS IN METALS.

larch and A.M.Murray.

Roy. Soc. A (GB), Vol. 261, 119-33 (April 11, 1961).

full perturbation treatment of the Dirac density matrix is ›ped as a basis for self-consistent calculations in free-on metals containing localized defects. The present perturba-eries is shown to sum to the well-known result for the case of varying potentials. To first order in perturbation theory, self-consistent results for the radial density of displaced e and the Hartree potential in the presence of point singulari-ave been obtained over a density range sufficient to cover all s under normal conditions. The basic limitations of Mott's order method, based on the assumption of slowly varying poten-are shown to be completely removed and the self-consistent y and potential display long-range oscillations. Finally, the ation of the present approach to Bloch wave-functions rather lane waves is briefly considered. Friedel's generalized first-method, applicable to a band structure, may be obtained from esent theory for sufficiently slowly varying potentials. tunately, such an assumption is seen by comparison with the electron findings to lead to serious errors.

247

SOME PHYSICAL CHARACTERISTICS OF DEFECTS IN DEFORMED METALS.

lertsriken and M.M.Novŷkov.

yin. fiz. Zh. (USSR), Vol. 4, No. 4, 527-9 (1959). In Ukrainian.

The thermo-e.m.f. method was used to study Ni, Cu and Ag.

248

DISTRIBUTION OF CRYSTAL LATTICE DEFECTS ALONG THE DIAMETER OF A SPECIMEN UNDER OUS TYPES OF DEFORMATION.

ertsriken, M.M.Novŷkov and V.S.Kopan'.

yin. fiz. Zh. (USSR), Vol. 4, No. 4, 530-3 (1959). In Ukrainian.

The thermo-e.m.f. method was used to study Ni, Cu and Ag.

249

INVESTIGATION OF ATOMIC DEFECTS IN COPPER, SILVER AND GOLD, BY MEANS OF ELECTRICAL STIVITY MEASUREMENTS.

ıllle, A.Seeger, F.Ramsteiner, D.Schumacher and K.King.

ıturforsch. (Germany), Vol. 16a, No. 3, 323-4 (March, 1961).
rman.

Measurements which have been made on point defects by the tance recovery technique are reviewed. The values of the ation energy, formation energy, and self-diffusion energy for ts which were obtained by the authors as well as by other ers are presented in a comprehensive table. A.J.Fox

4250

VACANCIES AND THE KIRKENDALL EFFECT.

H.H.Bleakney.

ıd. J. Phys., Vol. 39, No. 6, 947-51 (June, 1961).

An alternative explanation of the Kirkendall effect in brass is put forward, based on the difference in volume between an atom and a vacancy and not requiring any movement of vacancies.

H.Mykura

14251

CAVITY GROWTH BY VACANCY CONDENSATION AND TRANSFORMATION TO DISLOCATION LOOP IN THE GRAPHITE STRUCTURE.

T.Tsuzuku.

J. Phys. Soc. Japan, Vol. 16, No. 3, 407-13 (March, 1961).

The growth of cavities by vacancy condensation in graphite and their transformation to dislocation loops is investigated theoretically. During heat treatment of carbonaceous substances for graphitization, numerous vacancies and cavities presumably exceeding 10^{-3} at.% are introduced in several ways, e.g., decomposition and evaporation of various impurities. By taking account of the internal surface energy and the configurational entropy of them, it is concluded that these vacancies and cavities are driven to consolidate to fewer and larger ones lying extensively on the (00l)-planes. In the course of the steady dimensional growth, the cavity is expected to collapse to a prismatic dislocation loop under the compressive thermal stress in the c-direction (graphitization stress) caused by the interference between the anisotropically expanding crystallites. The criterion of such transformation is determined by comparing the self-energy of the dislocation loop with the sum of the surface energy of the original cavity and the compressive strain energy to be released by the collapse; i.e. the critical diameters range from about 100 A to 1100 A in accordance with the various conditions concerning the crystal modification and the cavity thickness. These values are in fairly good agreement with the experimental results. It is remarked that in this way the characteristic intercrystallite voids can be explained.

14252

ELECTROSTATIC ENERGY OF VACANCIES' ORDERING IN CRYSTALS OF THE MURDOCHITE TYPE, A_6BO_8.

U.Takahasi and Y.Sakamoto.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 647-52 (Dec., 1960).

After Madelung's coefficient had been calculated by Hund's method on several submodels of a generalized murdochite-type structure, the electrostatic lattice energy was evaluated on crystals of Mg_6MnO_8. The electrostatic part of the energy associated with the ordering of vacancies was found to be so large (379 and 344 kcal/mole, respectively) that it was considered that these structures were ordered. This conclusion adds support to that previously drawn by Kasper, Christ, and others (1953-55) from experiment and by Bertaut (1952) from theory.

14253

THE MOBILITY OF LATTICE VACANCIES IN SILVER.

Y.Quéré.

C.R.Acad. Sci. (France), Vol. 252, No. 16, 2399-2402 (April 17, 1961). In French.

Isothermal and isochronal resistivity recovery measurements were made on thin filaments of silver within which lattice defects had been created by heating and rapid quenching. The results are differentiated in terms of the value of the quenching temperature, Θ. When $\Theta < 600°C$, the isochronal waves show one stage of annealing which is interpreted to be due to the recombination of vacancies at fixed sites. The isothermal curves provide a range of displacement activation energies, E_d, the mean value being 0.86 ± 0.06 eV. Because the vacancy concentration is only about 1 in 10^6, this is taken to be characteristic of single vacancies. The magnitude of E_d is consistent with the accepted values of the activation energies for the creation of monovacancies and for self-diffusion in silver. When $\Theta > 600°C$, the isochronal measurements yield two stages, probably due to the agglomeration of defects at dislocations and to the subsequent disappearance of these dislocations by self-diffusion. The value of E_d obtained from the isothermal curves is 0.58 ± 0.02 eV, and this value is associated with the disappearance of double vacant sites. P.J.Dean

14254

STUDYING THE THERMAL ELECTROMOTIVE FORCE OF DEFORMED METALS.

S.D.Hertsriken and M.M.Novŷkov.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 640-53 (1959). In Ukrainian.

Assuming that the thermal e.m.f. arising in a couple of an annealed and deformed metal is due to vacancies and dislocations, certain characteristics of the latter are determined. The resistance of 1 per cent vacancies in Ag and Ni were found on the basis of the connection between the absolute thermal e.m.f. and the resistivity The resistance per unit length of dislocation was determined; for Cu, Ag and Ni it equals 6.8×10^{-14}, 16.3×10^{-14} and 14×10^{-14}

μohm/cm, respectively. The energy of activation of dislocation movement E_{md} was also obtained for these metals, being 23.8, 22.3 and 23.0 kcal/mol, respectively. The thermal e.m.f. was employed to determine E_V the energy of formation of quenched vacancies and E_{mv}, the energy of activation of their movement. For silver $E_V = 23.2$ kcal/mol, and $E_{mv} = 19.2$; the sum $E_V + E_{mv} = 42.4$ kcal/mol, which is close to the energy of activation of self-diffusion of silver.

14255 USING THE THERMO E.M.F. METHOD TO STUDY VACANCIES FIXED BY QUENCHING.

S.D.Hertsriken and M.M.Novȳkov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 681-3 (1959). In Ukrainian.

14256 INFLUENCE OF SILVER IMPURITIES ON THE ANNEALING KINETICS OF QUENCHED GOLD SPECIMENS.

F.Cattaneo and E.Germagnoli.
Phys. Rev. (USA), Vol. 124, No. 2, 414-19 (Oct. 15, 1961).

The recovery of quenched-in extra resistivity was studied in thin gold wires, to which atomic concentrations of silver equal to 1.2×10^{-3} or 1.4×10^{-4} were added. Recovery occurs at higher temperatures than for pure specimens, the effective activation energy being larger than 1 eV. The interpretation is that vacancy—impurity complexes are formed, whose binding energy is about 0.3 eV. Evidence of motion of defects at low temperature was also obtained in the case of impure specimens.

14257 DISTRIBUTION OF SILVER IONS IN MELT-GROWN ALKALI HALIDES.

W.Gomes.
J. chem. Phys. (USA), Vol. 34, No. 6, 2191-2 (June, 1961).

A study of the kinetics of dislocation decoration by treating crystals doped with AgCl in a stream of H at high temperatures. Contrary to ionic radii considerations Ag^+ ions are incorporated more easily in the NaCl than in the KCl lattice. R.F.Peart

14258 SPECULATION ON THE CENTRES FORMED BY NITROGEN IN DIAMOND.

R.J.Elliott.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 787-91 (Nov., 1960).

The relevant data on diamond are critically examined, e.g. crystal types (I and II), optical absorption, electron resonance, X-ray diffraction and lattice dilation. It is concluded that in one type of lattice defect the nitrogen is segregated into planes (100) and increases the planar spacing of the perfect lattice by one third. A two-nitrogen layer (N—C—N) structure seems probable. Electron resonance is associated with a single nitrogen centre.

G.F.J.Garlick

14259 THE ENERGY SPECTRUM OF DEFECTS ARISING IN Ge UNDER THE INFLUENCE OF γ-RADIATION.

N.A.Vitovskii, T.V.Mashovets, S.M.Rȳvkin and V.P.Sondaevskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 998-1001 (March, 1961). In Russian.

The energy levels of the defects are determined from the temperature coefficient of the Hall effect. The temperature dependence of electron concentration in the conduction band and of hole concentration in the valence band are also determined. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 727-9 (Sept., 1961)]. R.F.S.Hearmon

14260 DEFORMATION-PRODUCED POINT DEFECTS.

H.K.Birnbaum and F.R.Tuler.
J. appl. Phys. (USA), Vol. 32, No. 7, 1403-4 (July, 1961).

When f.c.c. metals are plastically deformed, point defects as well as dislocations are produced. An investigation on fine-grained high-purity Cu indicates how dislocations react with point defects and from an analysis of the reaction kinetics the activation energy for diffusion of the point defects is estimated. It is then concluded that the point defects are interstitials produced by the deformation.

C.A.Hogarth

14261 BIREFRINGENCE DUE TO DISLOCATIONS IN GLIDE BANDS OF ROCKSALT SINGLE CRYSTALS.

S.Mendelson.
J. appl. Phys. (USA), Vol. 32, No. 10, 1999-2004 (Oct., 1961).

Birefringence techniques are described which emphasize the difference in stress on each side of a slip plane having edge dislocations of one sign. The principal stresses due to edge dislocations in a glide band were found to be parallel and perpendicular to the Burgers vector. The opposite stressed regions on both sides of a slip plane produce opposite phase retardations in the light passing through the slip plane. When this light is retarded in phase
by an amount equal to the advancement from the compressiv
(or advanced by an amount equal to the retardation from the
region), a birefringence band forms which is, for instance,
the compressive side and light on the tensive side in a backg
of intensity half-way between these two shades. These asym
cally shaded birefringence bands are observed when viewed
normal and parallel to the Burgers vector, and this is show
a direct consequence of the edge dislocations in the slip pla
and to be independent of screws. The asymmetry of the ban
permits a determination of the sign of the slip plane disloca
and the apparent position of its source. The magnitude of th
principal stress parallel to the Burgers vector was compute
the measured retardations and found to be in good agreemen
that computed from the dislocation stress fields.

14262 X-RAY STUDY OF LATTICE DEFECTS IN Si SI CRYSTALS BY TRANSMISSION BERG—BARRET TECHNIQUE.

M.Yoshimatsu and K.Kohra.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2367-8 (Dec., 1960).

A modified version of Newkirk's technique [Transaction
the American Institute of Mechanical Engineers, Vol. 215, 4
(1959)] was used to image defects in thin crystals, contrast b
produced by extinction effects. An X-ray tube with "ordinar
focal spot size and a molybdenum target was used. Image re
tion is estimated at 10 μ. A (220) reflection photograph of a
single crystal 0.28 mm thick shows individual dislocation lin
A (111) reflection photograph of a section 0.5 mm thick, cut
to the twin plane, shows in addition streaks and bands attribu
lattice defects such as stacking faults. V.E.

14263 MODIFICATION OF THE KOEHLER—GRANATO LÜCKE DISLOCATION DAMPING THEORY.

J.C.Swartz and J.Weertman.
J. appl. Phys. (USA), Vol. 32, No. 10, 1860-5 (Oct., 1961).

Metals with high stacking fault energy are considered.
assumed that the most abundant impurity atom species only
acts with the edge component of each dislocation. For this
hysteretic (frequency independent) damping initially increase
linearly with stress amplitude, and at higher stresses appro
the Granato—Lücke amplitude dependence. The influence of
second, less abundant impurity atom species which can inter
both screw and edge components is also considered. When t
glide distance of a dislocation after breakaway is comparable
the mean spacing of the second type of impurity, the hystere
damping becomes amplitude independent. This modification
suited for application to the damping of b.c.c. metals contain
a higher concentration of substitutional than interstitial impu

14264 DEFECTS ON THE BOUNDARIES OF TWIN LAY

R.I.Garber and E.I.Stepina.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 514-19 (Feb., 1961)
In Russian.

Experiments are described on the production of etch fig
at twin boundaries in calcite. On the basis of the results so
suggestions are made regarding the mechanism of the forma
defects at twin boundaries. [English translation in: Soviet
Solid State (USA), Vol. 3, No. 2, 377-80 (Aug., 1961)].

R.F.S.H

14265 ENERGY OF A CROSSED GRID OF SCREW DISL TIONS.

J.C.M.Li.
J. appl. Phys. (USA), Vol. 32, No. 10, 1873-5 (Oct., 1961).

Calculated using isotropic elasticity theory. It is found
distortion from the stable structure requires a large amount
strain energy. It is indicated that long-range stresses can e
in metastable dislocation networks without a long pile-up of
dislocations. Possible rearrangements of dislocation netwo
both f.c.c. and b.c.c. metals are shown.

14266 EXPERIMENTAL STUDY OF THE INTERRELAT BETWEEN THE THEORY OF DISLOCATIONS IN POLYCRYSTALLINE MEDIA AND FINITE AMPLITUDE WA PROPAGATION IN SOLIDS.

J.F.Bell.
J. appl. Phys. (USA), Vol. 32, No. 10, 1982-93 (Oct., 1961).

By use of experimental data from a large number of free
impact tests involving diffraction grating measurement of st
detailed and very close experimental verification is given fo
Taylor theory of dislocations in polycrystalline annealed
aluminium. Applying the finite amplitude wave theory, with
theoretical parabolic stress-strain curve obtained from disl

, experimental and theoretical correlation within approxima-
ɔ are obtained for the velocities of strain propagation,
ıum strain, largest distance of penetration of maximum strain,
ic stress levels in the first diameter, time of contact,
ːient of restitution, mushrooming in the first diameter, and an
. balance before and after impact. Variations in the plastic
ievelopment and dynamic stress behaviour below the Karman
ıl velocity are considered theoretically and experimentally in
of a difference in the initial elastic reflection behaviour
the critical velocity. Plastic deformation is found to be
ndent of strain rate, even at experimentally determined values
0 in. in.$^{-1}$ Sec^{-1}. Initial shock fronts exceeding the dilatational
ty are experimentally identified near the impact face. The
ıuent development of dispersive plastic wave fronts following
ssage of the initial shock, also are found to be in accordance
redictions based upon dislocation theory. The equipartition
rgy in the vicinity of the impact face was found to be related
reflection behaviour of these initial shock fronts at the
l surface of the rod.

67 THE BASIC EQUATIONS OF THE DYNAMICS OF THE CONTINUOUS DISTRIBUTION OF DISLOCATIONS.
NERAL THEORY. E.F.Holländer.

. J. Phys., Vol. 10, No. 6, 409-18 (1960).
he basic equations of the dynamics of the continuous distribu-
f dislocations analogous to Maxwell's equations are derived
eries of papers. The analogy of the elastic and electro-
etic fields is analysed. In the present paper, the basic equa-
of the continuous distribution of dislocations are derived for
namic case (especially for small deformations and for the
on ratio equal to zero) in a continuum, infinite with respect
ce and time, from the variational problem by means of the
l apparatus of the special theory of relativity.

:68 THE BASIC EQUATIONS OF THE DYNAMICS OF THE CONTINUOUS DISTRIBUTION OF DISLOCATIONS.
TERPRETATION OF GENERAL THEORY. E.F.Holländer.

ı. J. Phys., Vol. 10, No. 7, 479-87 (1960).
. physical interpretation is given of the tensors of stress and
tion and expressions are considered for the energy density
elastic field of the dislocations. The basic equations are
alized for the case of a non-zero Poisson ratio and a finite
A detailed interpretation is given of the tensor components
location current density.

69 THE BASIC EQUATIONS OF THE DYNAMICS OF THE CONTINUOUS DISTRIBUTION OF DISLOCATIONS.
PECIAL PROBLEMS. E.F.Holländer.

. J. Phys., Vol. 10, No. 8, 551-60 (1960).
ome special problems are discussed, such as the density of the
s acting on the dislocations, the energy dissipation during the
nent of dislocations, which is expressed by an equation ana-
s to Ohm's law. The equations derived in the previous parts in
limensional symbolics are considered in the three-dimensional
ential and integral form. It is found that in special cases the
ons become the known ones of elastodynamics, hydrodynamics
ıe static theory of the continuous distribution of dislocations.
ound that Kröner's method of integrating the equations of the
ation field by means of so-called incompatibility tensors is
gous to the integration of the Maxwell equations by means of
vectors. The analogy between the elastic dislocation field and
ectromagnetic field is discussed in detail.

270 GENERATION AND DISTRIBUTION OF DISLOCATIONS BY SOLUTE DIFFUSION. S.Prussin.

ɔl. Phys. (USA), Vol. 32, No. 10, 1876-81 (Oct., 1961).
The stress introduced by solute lattice contraction of boron and
ɔhorus in silicon is shown to be sufficient to generate disloca-
in silicon wafers, which were observed. Expressions for the
ty distribution and the total number of dislocations generated
erived, and a mechanism of dislocation generation and dis-
tion during the diffusion process is postulated. The dislocation
ıbution is shown to be highly dependent upon the nature of the
ion process, expressions being derived for the conditions of
ɔnstant surface concentration of solute and (2) diffusion from a
source. An expression and means for determining the resi-
stresses in diffused silicon wafers are given.

14271 EXPERIMENTAL STUDIES ON ELECTRONIC TRAPPING PROCESSES ASSOCIATED WITH DISLOCATION LINES IN ALKALI HALIDE CRYSTALS. H.Ohkura.

J. Phys. Soc. Japan, Vol. 16, No. 5, 881-95 (May, 1961).

The trapping of conduction electrons by dislocation lines in alkali halide crystals was investigated by measuring the temperature dependence of photoconductances of deformed and undeformed crystals. Furthermore, the effect was verified by observing the thermally stimulated currents. In both cases, measurements of electric currents were carried out under the application of a.c. in order to avoid undesirable effects due to space charge formation. Special care was exerted to obtain crystals having a high degree of purity. From the first mentioned experiment, the effective width of dislocation lines for electron trapping was estimated to be 9.3×10^{-6} cm, by using dislocation densities determined from n.m.r. studies. The thermal depth of dislocation lines was estimated to be 0.21 eV for KBr and 0.24 eV for KCl crystals. A current glow peak, which may correspond to trapping by jogs, was also measured. The thermal depth of jogs was roughly estimated to be 0.48 eV.

14272 ARRANGEMENT OF DISLOCATIONS IN IRON. W.Carrington, K.F.Hale and D.McLean.

Proc. Roy Soc. A (GB), Vol. 259, 203-27 (Dec. 6, 1960).

The arrangement of the dislocations were studied in iron in various conditions, namely annealed, cold-worked, recovered and after creep. In all conditions the dislocation network is characterized by attractive intersections where two dislocations join to make one dislocation, and there is convincing evidence for the idea that at many of these intersections two $\frac{1}{2}a\langle 111\rangle$ dislocations join to make one $a\langle 100\rangle$ dislocation. These attractive intersections are thought to contribute substantially to the flow stress. There are also repulsive intersections but according to calculation they constitute weaker obstacles to flow than the attractive junctions.

14273 EFFECT OF ANNEALING UNDER HIGH PRESSURES ON DISLOCATIONS IN LITHIUM FLUORIDE, ALUMINUM, COPPER AND IRON.

J.E.Hilliard, J.M.Lommel, J.B.Hudson, D.F.Stein and J.D.Livingston.
Acta metallurgica (Internat.), Vol. 9, No. 8, 787-94 (Aug., 1961).

Single crystals of lithium fluoride, aluminium, copper and iron were annealed for 1 hr at 500°-600° C under a pressure of 40 kb. The dislocation structure was studied, before and after treatment, by the Berg—Barrett X-ray technqiue in aluminium and by etch pitting in the other materials. The high-pressure anneals produced no detectable change in the dislocation densities of any of the four materials. For lithium fluoride a double-etch technique revealed that far less dislocation motion had occurred in the crystal annealed under pressure than in one given the same thermal treatment at atmospheric pressure. These results are consistent with calculations which show that the application of pressure will reduce both the climb and glide rates of a dislocation.

14274 OBSERVATIONS OF DISLOCATION NETWORK IN NEUTRON-IRRADIATED LiF CRYSTAL.

K.Kubo and Y.Katano.
J. Phys. Soc. Japan, Vol. 16, No. 2, 347-8 (Feb., 1961).

LiF crystals were irradiated with a neutron flux of 2×10^{17} and annealed at temperatures up to 700°C. Phase contrast techniques were used to reveal dislocations in the form of polygonal networks, parallel lines and closed loops. R.F.Peart

14275 CHARGED DISLOCATIONS IN IONIC CRYSTALS. F.Rueda and W.Dekeyser.

J. appl. Phys. (USA), Vol. 32, No. 9, 1799 (Sept., 1961).

Further results are presented in support of the existence of charged dislocations produced during the indentation of pure and doped rocksalt, LiF, and MgO. Evidence of both positively and negatively charged dislocations is presented. Although it appears that vacancies affect the acquisition of this charge by moving dislocations, the lack of correlation between the amount of the charge and concentration of added impurity suggests a more complex mechanism. J.W.Taylor

14276 SINGLE AND DOUBLE PILE-UP OF DISLOCATIONS IN MgO CRYSTALS. Y.T.Chou and R.W.Whitmore.

J. appl. Phys. (USA), Vol. 32, No. 10, 1920-6 (Oct., 1961).

A quantitative analysis was made of elastic interactions in three types of dislocation pile-up groups in MgO crystals; (i) single pile-up, (ii) double pile-up on two orthogonal slip planes, and (iii) double pile-up on two slip planes intersecting at 120°. The equilibrium positions of dislocations in these groups are given. It is found that the stress concentration factor is highest in type (iii) and lowest in type (i). The number of dislocations in the pile-up groups sufficient to raise the tip stress to $1000\sigma_0$ is 1000 in type (i), about 120, determined by extrapolation, in type (ii), and 62 in type (iii).

14277 EXPERIMENTAL EVIDENCE FOR FRANK'S THEOREM ON DISLOCATIONS BY X-RAY DIFFRACTION MICROGRAPHY.

M.Yoshimatsu.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1465-9 (July, 1961).

In X-ray diffraction micrographs of a silicon single crystal, some nodes where three dislocation lines meet were observed. The Burgers vectors of these dislocations were determined, except for their sense, from the change in intensity contrast with different reflecting lattice planes. Frank's theorem (Abstr. 8345 of 1951), corresponding to Kirchhoff's law for electric current, was experimentally confirmed.

14278 OBSERVATION OF DISLOCATIONS IN SILICON USING THE ANOMALOUS TRANSMISSION OF X-RAYS.

A.Authier.

J. Phys. Radium (France), Vol. 21, No. 8-9, 655-9 (Aug.-Sept., 1960). In French.

A photographic study was made of dislocations in nearly perfect single crystals of Si. A crystallographic study of the observed dislocations is given. The dislocations are observed as fine double streaks, black and white.

14279 ON THE POSSIBILITY OF DETERMINING THE DENSITY OF DISLOCATIONS BY MEANS OF AN X-RAY SPECTROGRAPH WITH OSCILLATING FILM.

T.Bedyńska.

Acta phys. Polon. (Poland), Vol, 19, No. 4, 443-60 (1960).

A method of computing the distribution function of mosaic blocks in the crystal is proposed. For this, it is required that the forms of Bragg's reflex, as obtained on an X-ray spectrograph with fixed film, and that of the reflex, as obtained on a spectrograph with oscillating film, be known. If the distribution function of mosaic blocks is known, the density of dislocations can be computed.

14280 THEORY AND DIRECT OBSERVATION OF DISLOCATIONS IN THE Fe$_3$Al SUPERLATTICES.

M.J.Marcinkowski and N.Brown.

Acta metallurgica (Internat.), Vol. 9, No. 8, 764-86 (Aug., 1961).

It was found that in order for dislocations to travel through superlattices of the type D0$_3$, L2$_1$ and B2 without creating any net disorder across the slip plane, they must move as superlattice dislocations. A theoretical analysis of the superlattice dislocations in the D0$_3$ and L2$_1$ type structures shows that they should consist of four $\frac{1}{2}a_0\langle 111\rangle$ type ordinary dislocations bound together by two different type antiphase boundaries. On the other hand, superlattice dislocations in the B2 structure consist of pairs of coupled dislocations. Calculations were made of the separation between the superlattice dislocations for the specific case of the Fe$_3$Al alloy exhibiting both D0$_3$ and B2 type ordered lattices. It was found that for this specific alloy, the antiphase boundary energy associated with the superlattice dislocations is relatively low, resulting in a large extension of the individual dislocations constituting the superlattice dislocation. Becuase of this low energy, the possibility is suggested that dislocations might move through the Fe$_3$Al lattice as ordinary $\frac{1}{2}a_0\langle 111\rangle$ types. In order to determine experimentally whether or not dislocations travel through the lattice as superlattice dislocations or as ordinary dislocations, for the particular Fe$_3$Al alloy possessing both D0$_3$ and B2 type structures, thin foils of the alloy were examined using transmission electron microscopy. It was indeed found that the dislocations in this alloy travel as ordinary dislocations, leaving behind on their slip plane ribbons of antiphase boundaries. In addition, a preponderance of screw dislocations were observed to be present, which in turn gives rise to wavy or noncrystallographic type slip behaviour.

14281 DIRECT OBSERVATION OF THE LATTICE IMPERFECTIONS IN PEARLITES BY ELECTRON MICROSCOPY.

Z.Nishiyama, A.Kore'eda, I.Eguchi and K.Kato.

J. Phys. Soc. Japan, Vol. 16, No. 4, 834 (April, 1961).

Transmission electron microscopy confirms earlier results [J. Electron Microscopy (Japan), Vol. 7, 41 (1959)]. Boundary structures suggest parallel arrays of defects due to lattice coherency between cementite and ferrite. M.A.Taylor

14282 THE PRODUCTION OF DISLOCATIONS BY ELEC
EROSION OF SINGLE CRYSTALS.

L.S.Palatnik, A.A.Levchenko and V.M.Kosevich.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 96-9 (May 1, 1961).
In Russian.

Single crystals of antimony, bismuth and zinc were expo
to electric discharges in the form of sparks. Resulting lattic
defects were investigated by etching. It was found that disloc
were produced over a wide range and within a thin layer near
surface of the crystal. Their distribution is plotted against t
distance from the location of the spark. The number of dislo
per cm^2 is found to be of the order 10^6 even at distances of 1
at $\frac{1}{2}$ mm their number vanishes rapidly. [English translation
Soviet Physics—Doklady (USA)]. R.Eis

14283 DETECTION OF DISLOCATION DEFECTS IN ANTIMONY BY THE ETCH METHOD.

V.M.Kos

Kristallografiya (USSR), Vol. 5, No. 5, 749-56 (Sept.-Oct., 1
In Russian.

The etchant CP-4 was used for etching (111) plane.
patterns on the faces of blocks, slip lines, and elastic and st
twinned layers were detected. The dislocation defects produ
direct and reverse twinning were studied. [English translati
Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 715-2
(March-April, 1961)].

14284 ANTIMONY EDGE DISLOCATIONS IN InSb.

H.C.Gatos, M.C.Finn and M.C.Lavime.

J. appl. Phys. (USA), Vol. 32, No. 6, 1174-5 (June, 1961).

A new etchant (1 part 30% H_2O_2 + 1 part 48% HF + 8 H_2
butylthiobutane) was used to reveal In and Sb edge dislocatio
InSb single crystals. The latter were found to be electron d
and the former electron acceptors. R.

14285 THE FORMATION OF DISLOCATIONS IN THE TWINNING OF CALCITE.

V.I.Startsev, V.Z.Bengus, F.F.Lavrent'ev and L.M.Soifer.

Kristallografiya (USSR), Vol. 5, No. 5, 737-43 (Sept.-Oct., 1
In Russian.

Deals with the twinning process in calcite crystals, stud
the method of selective etching. It is shown that the observe
phenomena experimentally confirm certain hypotheses of the
tion theory and can be explained within its framework. [Eng
translation in: Soviet Physics—Crystallography (USA), Vol.
No. 5, 703-8 (March-April, 1961)].

14286 REVEALING DISLOCATIONS IN CdS SINGLE CRYSTALS BY THE ETCHING METHOD.

Zh.G.Pisarenko and M.K.Sheinkman.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1152-7 (April, 196
In Russian.

For abstract, see Abstr. 12392 of 1961. [English transl
in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 838-4
(Oct., 1961)].

14287 DISLOCATION DENSITY AND FLOW STRESS O
SODIUM CHLORIDE.

W. in der Schmitten and P.Haasen.

J. appl. Phys. (USA), Vol. 32, No. 9, 1790-1 (Sept., 1961).

Experiments were made on plastic flow of NaCl single c
in compression, followed by polishing and etching to determi
dislocation density. The relationship between shear stress
square root of dislocation density is linear, in contrast to th
findings of Johnston and Gilman (Abstr. 4019 of 1959) on LiC
Experiments in which the strain rate was varied indicated th
ence of a small thermally activated contribution to plastic fl
NaCl. R.F.S.

14288 DISLOCATION ETCH PITS ON THE BASAL PLA
OF ZINC CRYSTALS.

H.S.Rosenbaum and M.M

J. appl. Phys. (USA), Vol. 32, No. 10, 1866-72 (Oct., 1961).

An etch pit technique was developed that reveals the sit
dislocations intersecting the basal plane surface of zinc cry
Pits can be formed by either Cl$_2$, HCl, Br$_2$, HBr, or HI diss
an appropriate organic solvent. Etchants made with Cl$_2$ or
produce hexagonal pyramidal pits whose edges are parallel
directions; but Br$_2$, HBr, or Hi etchants produce hexagonal
edges parallel to $(11\bar{2}0)$ directions. The technique is useful
observing glide which occurs on non-basal planes. The disl

its are seen to form a "polygonization" pattern in a crystal
leo after deformation. A discussion is presented on the
unism of etch pit formation and the factors which might deter-
the shape of the pits.

289 MEASUREMENTS ON THE CONTRIBUTION OF THERMAL LATTICE DEFECTS TO STRUCTURAL
GY AND EXPANSION IN PURE METALS. H.U.Åström.

Fys. (Sweden), Vol. 18, Paper 34, 465-77 (1960).

'he development of thermal lattice defects was studied by means of
ermal calorimetry for gold, aluminium and molybdenum of
urity. The specimens, enclosed in argon-filled Pyrex con-
s, were heated from room temperature to various tempera-
in the range 160° to 480°C. The energy absorbed in order
ain equilibrium at the new temperature had an exponential
vith a time-constant of a few hours. Increasing temperature
to an isothermal absorption of heat which becomes larger with
asing purity of the metal. In addition, the thermal expansion
d was studied with an isothermal method. With the same
nnealings as in the calorimetric case a small exponential
sion was observed which took place with about the same rate
energy absorption. The temperature dependence of the
y and volume increase corresponded to an energy of forma-
f 0.11-0.26 eV. The time constants of the experimental
s changed, however, very little with temperature. As impuri-
vacancies and/or dislocations cannot explain more than a
part of the observed effects, it was assumed that they may
used by an unidentified type of thermal defect discussed by
ius.

fusion

290 A MORE PRECISE FORMULATION OF THE THEORY OF THE LOCALIZED CHARACTER OF THE CHEMICAL
TION DURING REACTIVE DIFFUSION IN SOLIDS.
ONDITIONS OF THE MAXIMUM DEGREE OF LOCALIZATION
HE REACTION AT THE BOUNDARIES OF THE PHASE OF THE
TITUTIONAL TYPE. V.I.Arkharov.

Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 709-17
1960). In Russian.

'or Pt I, see Abstr. 984 of 1961. Determines analytically the
ntration gradients across the diffusion layer which lead to the
mum degree of localization of the chemical reaction at the
laries of this layer, and derives expressions which qualitatively
cterize the conditions under which such localization takes
. M.H.Sloboda

291 ON THE STRUCTURAL CHARACTERISTICS OF [SURFACE] SCALE WHICH ARE UTILIZED IN
IES OF THE MECHANISM OF REACTIVE DIFFUSION.

rkharov and E.B.Blankova.

Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 878-87
, 1960). In Russian.

n an attempt to classify systematically the large volume of
imental data on reactive diffusion and to provide a rational
for qualitative evaluation of this phenomenon, the significance
following characteristics of scale, formed in the course of
ive diffusion, is discussed: texture of the scale layers; differ-
in the size of crystallites in relation to their distance from the
boundary; porosity or stratification in the layer boundary
ns; evidence of "self-induced" deformation (grain refinement);
e of the external shape of the specimen; displacement of inert
ers. M.H.Sloboda

1292 INVESTIGATION OF REACTIVE DIFFUSION IN BINARY METAL—GAS SYSTEMS. IV.

rkharov and E.B.Blankova.

Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 226-32
., 1960). In Russian.

For Pt I, see ibid., Vol. 10, No. 1, 63-9 (July, 1960).
retical. It is inferred from various experimental data, corre-
with theoretical considerations, that of all the crystallographic
rs affecting the mechanism of reactive diffusion, the nature
atomic bond between the components of the reaction products
e most important. In the case of reactive diffusion process is
metal—gas systems, the relative importance of the diffusion
etalloids may be associated with the increase in the part
d by homopolar bonding. The possibility of an elementary diffusion process is postulated during which, owing to the existence of homopolar bonding, local redistribution in electron density takes place, accompanied by the formation of an atomic complex, consisting of a metalloid ion, located on a vacant site of the metal sublattice, and several metal ions with locally changed valency. This hypothesis provides an explanation of the effect of the variation in the concentration of the components on the relative part played by their diffusion in the process studied, particularly in those cases that cannot be explained in terms of the crystal geometry alone. Based on these consideration, an explanation is formulated of the mechanism of reactive diffusion in systems formed by any metal—metalloid combination of the Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, W, and O, S, Se, Te series, and in the Fe—P, Co—P, and Ni—P systems. M.H.Sloboda

14293 DIFFUSION IN A PLASTICALLY DEFORMED MEDIUM. B.Ya.Lyubov and N.S.Fastov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 310-12 (Aug., 1960). In Russian.

Presents a method, claimed to be simpler and more logical than that due to Simmons and Dorn (Abstr. 842 of 1959), of deriving and solving the equation for diffusion in a plastically deformed material. M.H.Sloboda

14294 DIFFUSION OF IMPURITIES IN AN INFINITE PLATE. A.N.Murin and G.P.Samosyuk.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 342-9 (Feb., 1961). In Russian.

Discusses diffusion of an impurity in a plate located in a reservoir which is being evacuated at a finite rate, with allowance for possible adsorption of the impurity on the plate surface. The results are applicable to removal of impurities from semiconductors. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 245-51 (Aug., 1961)]. S.Chomet

14295 DIFFUSION IN A CHEMICAL CONCENTRATION GRADIENT. J.R.Manning.

Phys. Rev. (USA), Vol. 124, No. 2, 470-82 (Oct. 15, 1961).

The concept of correlation reverse jumps is used to treat correlation effects in a chemical concentration gradient. It is shown that the correlation factor associated with a given atom jump will be very nearly the same as that in a homogeneous alloy having the composition associated with the point midway between the initial and final atom positions for that jump. This is true for either a vacancy or interstitialcy mechanism. With the aid of this result, expressions for the atom flux of a given species and the mean atom displacement of a layer of diffusing atoms are derived from a purely atomisticapproach taking correlation effects into account. These expressions differ from equations obtained by Darken (1948) and LeClaire (Abstr. 8492 of 1958) in that they contain extra terms which arise where there is a flow of vacancies or interstitialcies. These extra terms can appreciably increase the predicted Kirkendall shift. They appear as both diagonal and cross terms in the general thermodynamic formulation of the diffusion equations. The method used here to analyse the effect of a chemical concentration gradient can also be used to study the effect of other types of gradients and external driving forces.

14296 NEW METHOD OF DETERMINING THE SURFACE DIFFUSION COEFFICIENT. V.G.Lozovik.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 460-7 (1958). In Ukrainian.

Discusses the two-dimensional boundary problem for diffusion in an inhomogeneous medium consisting of a semi-plane $y > \delta$ with coefficient of diffusion D and a surface $(-\infty < \chi < +\infty; 0 < y < \delta)$ with a coefficient of diffusion D_1. The formulae obtained are applicable to the practical computation of the coefficient of surface diffusion D_1.

14297 THE INFLUENCE OF STRESSED STATES ON THE DIFFUSION PROCESS IN BINARY SOLUTIONS.

O.S.Zdorovets'.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 357-62 (1959). In Ukrainian.

A diffusion equation is obtained from the expression for the free energy of a strained solid solution with finite velocity which at $\partial(\Delta\epsilon_{ll})/\partial t = 0$ and $\partial(\Delta C)/\partial t = 0$ is reduced to the diffusion equation of Konobeevskii [Zh. tekh. fiz. (USSR), Vol. 13, No. 6 (1943)] and Lyubov and Fastov [Dokl. Akad. Nauk SSSR, Vol. 84, No. 5 (1952)]. The problem of lateral elastic wave propagation in a relaxing solid solution is solved. The damping constant, the rate of propagation and the absorption constant are determined.

14298 THEORY OF ELECTRICAL MIGRATION IN METAL SOLIDS.

M.D.Hlinchuk.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 684 (1959). In Ukrainian.

THE MIGRATION OF SOLID METAL SOLUTION COMPONENTS IN A DIRECT-CURRENT FIELD. I. See Abstr. 12655

14299 DETERMINATION OF THE PARAMETERS OF VOLUME AND BOUNDARY DIFFUSION OF Ag IN Al.

S.D.Hertsriken and A.L.Revo.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 127-9 (1959). In Ukrainian.

The volume diffusion was measured in the temperature range 450-620°C; the boundary diffusion in the range 220-320°C.

14300 NEW METHODS OF STUDYING PARTIAL DIFFUSION AND ELECTRICAL MIGRATION COEFFICIENTS IN BINARY ALLOYS.

Ye.I.Khar'kov and P.P.Kuz'menko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 534-6 (1959). In Ukrainian.

Includes data from a study of Al and Fe migration in Fe-Al alloys (20, 30 and 40 at.% Al) in the temperature range from ~ 1100 to 1300°C.

14301 ON THE DETERMINATION OF DIFFUSION COEFFICIENT OF BORON IN SILICON.

J.Yamaguchi, S.Horiuchi, K.Matsumura and Y.Ogino.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1541-2 (Aug., 1960).

The method of Rohan et al. [J. Electrochem. Soc., Vol. 106, 705 (1951)] was used under constant surface concentration conditions. Measurement of diffusion coefficients in the temperature range 1160-1340° C yielded the equation $D = 17.1 \exp(-84.800/RT)$ cm² sec^{-1}.

R.F.Peart

14302 ANOMALOUS DIFFUSION AT THE INTERFACE OF THIN BIMETALLIC FILM OF Bi AND Sb.

R.Suganuma, T.Yoshida and Y.Fujiki.
J. Phys. Soc. Japan, Vol. 16, No. 4, 676-87 (April, 1961).

The intermetallic diffusion was studied by electron and X-ray diffraction and electrical resistance measurement on vacuum deposited thin bimetallic films of Bi and Sb. The formation of a triple-layer, which consisted of two outer layers of Bi and Sb and the intermediate layer of solid solution of the definite composition, was observed in the course of heating in vacuum. Such an anamalous diffusion could not be expected from a usual diffusion couple of bulk specimens. It was found that the degree of such a triple-layer formation depended on the kind and deposition rates of secondary deposits, and the maximum thickness of the intermediate layer attained by diffusion was confined to a certain limiting value. The defectiveness of films was deduced from electrical resistance measurements, the results of which were related to the triple-layer formation. Tentative explanations and discussions for this are proposed, assuming the existence of some strained intermediate layer of a certain thickness where the diffusion rapidly took place.

14303 DIFFUSION OF TUNGSTEN IN A COBALT-BASED ALLOY.

I.I.Kovenskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 350-3 (Feb., 1961). In Russian.

Reports a study of diffusion of tungsten in an alloy consisting of cobalt and a small amount of tungsten. Using a radioactive tracer W^{185} the following equation for the diffusion coefficient D was obtained: $D = 2.88 \exp(-68\,000/RT)$ cm²/sec, where R is the gas constant and T is the absolute temperature. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 252-4 (Aug., 1961)].

S.Chomet

14304 ELECTRICAL MIGRATION IN Cd AND Zn.

P.P.Kuz'menko and Ye.I.Khar'kov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 537-8 (1959). In Ukrainian.

Cd was investigated at 250°C in the current density range 15-192 A/mm²; Zn at 370°C, 27-164 A/mm². In both cases there is a linear relationship between the rate of migration and the current density.

14305 QUANTUM EFFECTS IN DIFFUSION: INTERNAL FRICTION DUE TO HYDROGEN AND DEUTERIUM DISSOLVED IN α-IRON.

W.R.Heller.
Acta metallurgica (Internat.), Vol. 9, No. 6, 600-17 (June, 1961).

An experimental and theoretical study. A torsion pendulum was employed and was used in a Collins cryostat at temperatures in the range 4.2°-300°K. A peak of damping was found in the range 105°-120°K corresponding to that earlier studied by Gensamer and co-workers [Ibid., Vol. 1, 483 (1953); Vol. 5, 692 (1957)]. Ar additional peak associated with hydrogen was found at 30°K correspondingly, one associated with deuterium was found at 35°K. Magneto-mechanical damping was found at all temper with a peak in the range 4.2°-15° K depending upon treatment the metal specimen. Theoretical arguments are advanced w suggest that the isotope-shifted peaks are due to atoms diss in the undistorted lattice, whose motion must be treated qua mechanically to account for the experimental results. Tunne and localized lattice distortions around the dissolved atom se be required by the data and are within the scope of a reason theory.

14306 SELF-DIFFUSION IN 50—50 GOLD—CADMIUM.

H.B.Huntington, N.C.Miller and V.Nerses.
Acta metallurgica (Internat.), Vol. 9, No. 8, 749-54 (Aug., 19

Self-diffusion studies were carried out on nominally 50- Au—Cd alloys by the standard sectioning technique using rad isotopes Cd^{115} and Au^{198}. From 300° to 590° C the results ar fitted by the values Q = 28.0 kcal/mole and $D_0 = 0.23$ cm²/se cadmium and Q = 27.9 kcal/mole and $D_0 = 0.17$ cm²/sec for g Between 590° C and the melting point at 626° C there is a mar upward curvature in both diffusion plots. The ratio of the di ivities is roughly 4 : 3 throughout and is consistent with a m anism of nearest-neighbour vacancy jumping. The activatio energies for diffusion exceed the sum of energies for vacan formation and motion previously reported. Two possible exp ations for this discrepancy are suggested.

14307 ELECTRICAL-DIFFUSION STUDIES OF THE BEHAVIOUR OF INDIUM AND ANTIMONY IMPURITIES IN GERMANIUM.

B.P.Konstantinov and L.A.Ba
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2696-2702 (Nov., 1 In Russian.

Reports studies of transport of indium and antimony in germanium monocrystals on passage of a constant current at 300-600° and 800-900°C. Below 600°C indium, moved towards anode and antimony towards the cathode; above 800°C indium towards the cathode and antimony towards the anode. Some o atoms had an anomalously high mobility (10^{-6} cm²V^{-1} sec^{-1}) w did not agree with the measured diffusion coefficients of indiu antimony in germanium. This anomalous mobility rose with increase of temperature. [English translation in: Soviet Phys Solid State (USA)].

A.Tybu

14308 DIFFUSION OF ZINC AND TIN IN INDIUM ANTIM

S.M.Sze and L.Y.Wei.
Phys. Rev. (USA), Vol. 124, No. 1, 84-9 (Oct. 1, 1961).

The diffusion of Zn and Sn in single-crystal and polycrys InSb was studied with the radiotracer technique. The tempera dependence of the diffusion coefficients can be represented by $D(Zn) = 1.4 \times 10^{-7} \exp(-0.86/kT)$ cm²/sec and $D(Sn) = 5.5 \times 1$ $\exp(-0.75/kT)$ cm²/sec in single-crystal InSb; and $D(Zn) = 1.1 \times 10^{-6} \exp(-0.85/kT)$ cm²/sec in polycrystalline InSb, t activation energies being in electron volts. From the penetra curves, it appears that in polycrystalline InSb the zinc diffusi a volume diffusion while the tin diffusion is mainly a grain bo diffusion. The different behaviours of zinc and tin in InSb are cussed on the basis of one-type and two-type vacancy mechani

14309 INVESTIGATION OF ATOMIC MOBILITY AT HIG TEMPERATURE AXIAL COMPRESSION IN FERR TYPE ALLOYS.

I.Ya.Dekhtyar and V.S.Mikhalenkov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 516-20 (1958). In Ukra

The effect of plastic strain on the diffusion of iron was st in a commercial KB-7 alloy (83 wt % Fe, 12 wt % Cr, balance Mo, V, W). The coefficients of diffusion were determined at t tures of 900° and 1000° C by means of the radioactive isotope employing the absorption method and taking into consideration correction for change of area of the specimen by deformation. strain was produced by applying an axial load to the surface o specimen during diffusion annealing. The coefficient of diffusi was found to increase in direct proportion to the rate of defor The results confirmed the supposition previously expressed b authors (Abstr. 14324 of 1961) that the increase in the diffusion coefficient during plastic strain is connected with the excess vacancies arising during the motion and interaction of dislocat and agrees with the formula derived on the basis of this assum This formula enables one to estimate the density of the disloca in the alloy at the temperatures involved in the investigation.

inishes with the temperature and proves to be much lower than values given in the literature. This is evidently connected with fact that, on estimating the density of the dislocations from the usion data, not all dislocations are taken into account, but only se that, on interacting, generate vacancies.

14310 INVESTIGATION OF REACTIVE DIFFUSION IN "METAL—COMPOSITE GAS" SYSTEMS. IV. THE LYBDENUM—NITROGEN—CARBON SYSTEM.

.Arkharov, V.N.Konev and A.F.Gerasimov.
. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 695-700 ay, 1960). In Russian.

The reaction between Mo and N started at 700°C, the time- endence of the process being parabolic at temperatures up to 0°C; above this temperature no Mo nitrides were formed. The lex surface layer formed on Mo at 700-900°C consisted of an er MoN layer with a simple hexagonal lattice, and an inner layer Mo_2N with f.c.c. structure. The surface layer formed at)-1150°C consisted of Mo_2N only. The temperature dependence the logarithm of the nitriding rate was represented by a curve nsisting of three linear branches. Molecular N at atmospheric essure did not react with Mo at 600-1200°C. The reaction between and C (in a mixture of H and benzene) started at 1000°C; its ne-dependence was parabolic at 1000-1200°C, and it resulted in formation of a Mo_2C layer with hexagonal crystal lattice. nilar results were obtained for the Mo—N—C system, but in this se the surface layer, formed as a result of reactive diffusion, nsisted of $Mo_2(C_{1-x}N_y)$ with the crystal structure of Mo_2C.

M.H.Sloboda

14311 INVESTIGATION OF REACTIVE DIFFUSION IN "METAL—COMPOSITE GAS" SYSTEMS. V. THE IROMIUM—SULPHUR—NITROGEN SYSTEM.

I.Arkharov, V.N.Konev and V.P.Pavlova.
z. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 701-8 lay, 1960). In Russian.

X-ray, metallographic, and gravimetric analyses were used study the diffusion phenomena in the Cr—S and Cr—S—N stems. It was established that the time-dependence of diffusion 700-1000°C is parabolic in both systems, the rate of the scale rmation being faster in the presence of N. The scale formed on , heated in the presence of S only, consists of two layers. The ter layer, metallic in appearance, changes its composition om Cr_2S_3 at 1000°C to Cr_3S_4 at 700°C, the composition of the dark, ner layer corresponding to Cr_5S_6. The reactive diffusion in the r—S system entails countercurrent diffusion of both components rough the layer of the products of the reaction, the relative part ayed by diffusion of Cr increasing with rising temperature. In e case of the Cr—S—N system, S and N diffuse towards the etal through the crystal lattice of the scale, and Cr diffuses wards the surface of the scale. The temperature-dependence n log K—1/T coordinates) of the parabolic constant of reactive ffusion, linear for the Cr—S system, is more complex for the r—S—N system.

M.H.Sloboda

14312 KIRKENDALL EFFECT AND DIFFUSION IN THE GOLD—PLATINUM SYSTEM. I. THE KIRKENDALL FFECT. A.Bolk.

cta metallurgica (Internat.), Vol. 9, No. 7, 632-42 (July, 1961).

The Kirkendall effect was studied in the gold—platinum system, ne of the rare systems with a miscibility gap in the solid state. ne effect was measured as a function of time and temperature in great number of "sandwich" couples. These couples consisted of re gold and pure platinum, polycrystalline and singlecrystalline, d of pure gold and a gold-rich alloy with 73.5 at.% gold. It could established, as a consequence of the obtained accuracy of the easurements, that the difference in magnitude of the effect in ouples with polycrystalline platinum and in couples with single-rystalline platinum has a physical significance. It has been inter-reted in terms of an extra diffusion transport along the grain oundaries in polycrystalline platinum. Besides the Kirkendall ffect the phenomena associated with this effect, such as porosity, imensional and structural changes, were studied as well as the hase-boundary displacement.

14313 KIRKENDALL EFFECT AND DIFFUSION IN THE GOLD—PLATINUM SYSTEM. II. THE CONCENTRATION ENETRATION CURVES AND THE DIFFUSION COEFFICIENTS.

.Bolk.
cta metallurgica (Internat.), Vol. 9, No. 7, 643-52 (July, 1961).

During the interdiffusion of gold and platinum a phase boundary appears, which can be seen from the concentration penetration curves; these curves are discussed in this part of the paper. The overall diffusion coefficient was calculated from the curves according to the graphical method of Matano. From the observed Kirkendall displacement and the data concerning the concentration gradient and the concentration in the marker interface, the partial diffusion coefficients could be calculated. From the ratio between the partial diffusion coefficients a quantity was derived which enables one to express the magnitude of an observed Kirkendall effect in a numerical value between 1 and 0.

14314 DIFFUSION AND ELECTROLYTIC MIGRATION OF P^{32} IN KCl CRYSTALS IRRADIATED WITH 660 MeV PROTONS.

A.N.Murin, B.G.Lur'e, S.N.Banasevich, G.P.Samosyuk and Ya.L.Ignatovich.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 398-407 (Feb., 1961). In Russian.

The diffusion coefficients of P^{32} atoms were measured in KCl crystals (P^{32} was formed on irradiation of the crystals with 660 MeV protons). At high temperatures the activation energy of the diffusion process was 3.2 eV. In electrolytic migration, P^{32} moved as a negatively charged ion with an effective charge of 0.2e. The aggregations of P^{32} atoms at the crystal surface were due to the substitution of lattice ions by phosphorus or due to the formation of oxides. The negative charge of P^{32} is interpreted in terms of the thermodynamics of irreversible processes. Phosphorus is considered to enter the KCl lattice in the form of negative P—Cl complexes. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 290-6 (Aug., 1961)].

S.Chomet

14315 BORON DIFFUSION IN SILICON.

E.L.Williams.
J. Electrochem. Soc. (USA), Vol. 108, No. 8, 795-8 (Aug., 1961).

The diffusion of boron in silicon was investigated by a p—n junction method over the temperature range of 1050°-1350°C and in silicon material where the n-type impurity density varied over a range 2×10^{13} to 8×10^{19} at./cm^3. The diffusion coefficient was found to decrease gradually as the purity of the n-type silicon increased. For silicon on the order of 0.1 ohm cm resistivity $D = 16 \exp(-85 \pm 5 \text{ kcal}/RT)$ cm^2 sec^{-1}. The effect on the diffusion coefficient of both the bulk impurity density and the boron density in the surface region is discussed.

14316 A THEORY OF DIFFUSION OF IMPURITIES IN PURE SILVER. J.M.Tobin.

Acta.metallurgica (Internat.), Vol. 8, No. 11, 781-7 (Nov., 1960).

Using an ionic model in which it is assumed that silver, copper, gold and the non-metallic elements are monovalent in the metallic lattice while the rest of the metallic elements are divalent, calculations of the activation energy (H) and the frequency factor (D_0) were made for period 5 elements. Better agreement was obtained between theoretical and experimental values. The calculations were extended to elements in periods 4 and 6 by taking into account the difference in ion-core size and effective nuclear charge. Experimental and theoretical values of H were within 3% for all elements except gold.

A.E.Kay

14317 DIFFUSION OF COBALT INTO SILVER.

T.Hirone and H.Yamamoto.
J. Phys. Soc. Japan, Vol. 16, No. 3, 455-8 (March, 1961).

The diffusion coefficient of Co into Ag was measured as a function of temperature over the range from 745° to 943°C by the tracer and lathe-sectioning technique. It was found that the diffusion coefficient can be expressed as follows:

$$D = (104) \exp \frac{59.9}{RT} 10^3 \text{ cm}^2 \text{ sec}^{-1}.$$

The value of activation energy, 59.9 K cal mol^{-1}, obtained by the present experiment is in good agreement with the result of the screening theory of impurity diffusion, but considerable discrepancy is found between the observed and theoretical frequency factor. The amount of diffused Co shows an abnormal decrease near the diffusing surface, which may be caused by the low solubility limit of Co in Ag.

14318 DIFFUSION AND OXIDE MASKING IN SILICON BY THE BOX METHOD. L.A.D'Asaro.

Solid-State Electronics (GB), Vol. 1, No. 1, 3-12 (March, 1960).

The "box method" for solid-state diffusion into silicon uses an impurity oxide dissolved in SiO_2 as a source of diffusant within a loosely closed box. The surface concentration of the impurity in the silicon can be varied over several orders of magnitude by a variation of the source composition. The method is well adapted for the use of a silicon oxide layer as a mask against diffusion. The masking action is particularly effective if the impurity oxide concentration in the source is below the value which produces a liquid. Specific experimental results are reported for the diffusion of boron and phosphorus. For example, oxide masking against diffusion was obtained in 0.3 ohm cm silicon under a condition which gave in unoxidized regions a diffused layer with a surface concentration greater than 10^{20} atoms/cm^3 and a junction depth of 3×10^{-4} in.

14319 MIGRATION OF SILVER ON PASSING DIRECT CURRENT THROUGH IT.

P.P.Kuzmenko and Ye.I.Khar'kov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 528-36 (1958). In Ukrainian.

The investigation established the migration of matter in solid silver (99.99% Ag) on passing a direct current through it. The dependence of the migration on the time, temperature and current density was studied. A simple theory agreeing with the experimental results is advanced to explain this effect.

14320 DIFFUSION OF Zn IN ZnO.

E.A.Secco.
Canad. J. Chem., Vol. 39, No. 7, 1544-8 (July, 1961).

Study of earlier data on the exchange of Zn vapour with polycrystalline ZnO at temperatures between 720° and 840°C suggests that the diffusion coefficient is equal to the product of the exchange coefficient with either the parabolic rate constant derived from oxidation data or the diffusion coefficient from conductivity studies. From this it is deduced that the exchange reaction and zinc diffusion occur simultaneously via interstitial sites and consequently the rate of the former is very dependent on the number of available sites. Exchange experiments to test this hypothesis were made with ZnO previously saturated with Zn vapour. The diffusion coefficients calculated from the experimental data are in good agreement with those from earlier exchange work and support the hypothesis. The frequency factor differs by a few orders of magnitude from the value which is calculated on the basis of the hypothesis.

A.E.Kay

ELECTROMIGRATION OF LITHIUM IN VITREOUS SILICA.
See Abstr. 13972

14321 EFFECT OF TORSIONAL DEFORMATION ON SELF-DIFFUSION IN SILVER.

C.H.Lee and R.Maddin.
J. appl. Phys. (USA), Vol. 32, No. 10, 1846-51 (Oct., 1961).

It is shown that plastic deformation by torsion at temperatures between 700° and 800°C enhances self-diffusion in silver single crystals. The enhancement varies linearly with surface strain rate, is larger the lower the temperature and is independent of surface strain. The results of experiments at constant stress are discussed in relation to ideas developed by Weertmann. The lifetime of point defects (assumed to be vacancies) at 800°C was measured as about 100 sec; this permitted the calculation of the concentration of vacancies produced per unit strain.

14322 RADIATION ENHANCEMENT OF BULK DIFFUSION IN 10% Zn—90% Cu BY 30 keV Ne+ ION BOMBARDMENT.

R.A.Arndt and R.L.Hines.
J. appl. Phys. (USA), Vol. 32, No. 10, 1913-19 (Oct., 1961).

Diffusion coefficients for zinc in 10% Zn—90% Cu single crystals were determined for both irradiated samples and unirradiated samples. The zinc lost from the samples was measured when they were heated in a vacuum of 3×10^{-5} mm Hg at temperatures from 207°C to 316°C. The zinc loss was measured by observing the change in optical reflection coefficient at a wavelength of 550 mμ. The diffusion length $(Dt)^{1/2}$ was then found using the known optical constants of ZnCu alloys and the expected concentration distribution, and the lengths thus obtained range from 20 to 1000 A. Bombardment by a 30 keV Ne^+ ion beam of 2.9 $\mu A/cm^2$ produces defects at a calculated rate of 4.5×10^{-2} atomic fractions sec^{-1} over the 300 A depth penetrated by the beam. For well-annealed samples the bombardment enhances the diffusion. The radiation-enhanced diffusion coefficient depends on the square root of the bombarding flux density and has an activation energy of 9300 ± 1700 cal/mole. The results agree with theoretical predictions for enhanced bulk diffusion for the case of defects annealing by direct recombination plus linear anneal to fixed sinks.

14323 EFFECTS OF GROSS IMPERFECTIONS ON CHLO ION DIFFUSION IN CRYSTALS OF SODIUM CHLO AND POTASSIUM CHLORIDE.

L.W.Barr, I.M.Hoodless, J.A.Morrison and R.Rudham.
Trans Faraday Soc. (GB), Vol. 56, Pt 5, 697-708 (May, 1960).

The diffusion of the chloride ion was measured in a variet specimens of NaCl and KCl in the temperature range 300° < T using an isotopic exchange technique. The results show that th diffusion is very sensitive to the presence of gross imperfecti such as grain boundaries and dislocations in the crystals. The general effect of a decrease in the dislocation density is to re the anion diffusion coefficient (in some examples by a factor o and to increase the apparent activation energy. Well-annealed single crystals of NaCl (dislocation density ~ $10^4/cm^2$) display a s range of diffusion (E = 2.55 ± 0.05 eV) but similar crystals of show two ranges (E = 2.6 ± 0.1 eV and E = 1.9 ± 0.1 eV) with a transition in the region of 540°C. The reason for this differen behaviour is not understood but possible explanations are disc The present results are compared with results for polycrystal specimens of the alkali halides obtained by Laurent and Benar [J. Phys. Chem. Solids (GB), Vol. 7, No. 2-3, 218-27 (Nov., 19 using an entirely different experimental technique. While differ- ences in detail are found, it is concluded that both sets of resu are in agreement with regard to the general effects of internal boundaries on the diffusion process. The most important obser- vation is that an increase in dislocation or boundary density do not cause deviations from the kinetics of simple bulk diffusion requirement of a single form of kinetics narrowly restricts th choice of possible detailed mechanisms. A mechanism propos by Hart [Acta metallurgica (Internat.), Vol. 5, 597 (1957)] can applied if it is assumed that the dislocations act over long dist in the crystals.

14324 EFFECT OF PLASTIC FLOW ON DIFFUSION IN NICKEL—MOLYBDENUM ALLOYS.

I.Ya. Dekhtyar and V.S.Mÿkhalenkov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 385-90 (1958). In Ukra

Cobalt diffusion in nickel alloys with 6.5, 9.6 and 16.7 ato per cent of molybdenum was investigated at temperatures of 95 1050° and 1150°C in the process of plastic flow. It was found t at low rates of flow, the coefficient of diffusion increases proportionally to the rate of flow. At high rates of flow, the diffusion rate increases with the rate of flow more rapidly tha linearly. The results may be explained by proceeding from th assumptions that vacancies appear during motion and that dislocations interact. The excessive diffusion coefficient is du to the excessive concentration of vacancies, as compared with equilibrium concentration. On the grounds of such a model, an expression is obtained for the excessive coefficient of diffusio which proved to be proportional to the rate of plastic flow. Th concept of the softening coefficient is introduced, which is a derivative of the diffusion coefficient with respect to the rate c flow. The softening coefficient rises with temperature and, depending on the concentration, has a minimum in the alloy wit 9.6 atomic per cent of molybdenum.

14325 ELECTRICAL [DIFFUSION] TRANSPORT IN SOL [IN TEMPERATURE RANGE 500-570°C].

P.P.Kuz'menko and Ye.I.Khar'kov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 401-2 (1959). In Ukrai

14326 THERMAL DIFFUSION OF OXYGEN AND NITROG ZIRCONIUM.

G.D.Rieck and H.A.C.M.Bruning.
Nature (GB), Vol. 190, 1181-2 (June 24, 1961).

Strips of Zr containing up to 6% oxygen were heated by a.c vacuo. The temperatures along strips varied from about 1700° 1000°C. The oxygen content after heating was estimated from ness measurements, and the oxygen was found to move to the c parts. N in Zr, and O and N in Ti seem to behave similarly.

H.M

FIELD-ENHANCED DONOR DIFFUSION IN DEGENERAT SEMICONDUCTOR LAYERS. See Abstr. 14422

lour Centres

14327 ON THE NATURE OF COLOUR CENTRES IN OXYGEN-DEFICIENT $BaTiO_3$ SINGLE CRYSTALS.

oufová and H.Arend.
ch. J. Phys., Vol. 11, No. 6, 416-23 (1961).

A study was made of the conditions under which oxygen non- chiometry of $BaTiO_3$ single crystals is created by their thermal tment in atmospheres with different partial pressure of oxygen. bands with maxima at 0.48 μ and 0.64 μ were found in the visible ion in the absorption spectrum of crystals deficient in oxygen. attempt was made to find an interpretation of the structure of -stoichiometric $BaTiO_3$ and a model of the appropriate colour tre was proposed for the band with a maximum at 0.64 μ.

14328 COLOUR CENTER AND GASEOUS IONS PRODUCED IN HIGH FREQUENCY SPARK BETWEEN THE ELECT- DES OF SEMI-METALS, METAL ELEMENTS AND IONIC YSTALS. T.Yuasa.

Phys. Soc. Japan, Vol, 15, No. 10, 1900 (Oct., 1960).

14329 THE COLORATION OF SYNTHETIC CaF_2 SINGLE CRYSTALS PRODUCED FROM PURE SYNTHETIC W MATERIAL. P.Görlich, H.Karras and R.Reimann.

Deutschen Akad. Wiss. Berlin, Kl. Math. Phys. Tech. (Germany), 0, No. 3, 34 pp. In German.

The preparation of CaF_2 single crystals is described. Measure- nts were made of the absorption, fluorescence and coloration perties of the crystals. The relation between radiation dose and tractive coloration spectra was investigated for the systems F_2/U, CaF_2/Sn, CaF_2/Y, CaF_2/Sm, CaF_2/Yb, CaF_2/Eu, CaF_2/Gd CaF_2/Ce. The bleaching process on storage in the dark was died.

J.Franks

14330 ELECTRON SPIN RESONANCE AND OPTICAL ABSORPTION OF ELECTRON EXCESS CENTERS IN l. P.R.Moran, S.H.Christensen and R.H.Silsbee.

ys. Rev. (USA), Vol. 124, No. 2, 442-9 (Oct. 15, 1961).

The effect of various conditions of optical bleaching and thermal ealing on the electron spin resonance and optical absorption of itively coloured KCl was studied. With extended optical bleaching resonance linewidth narrows and the resonance saturates less adily. The presence of R, M, N, or R' centres is unrelated to dominant features of the changes in resonance behaviour; the ical absorption associated with the magnetic centres appears to main in the region of the F-band.

14331 RELATIONSHIP BETWEEN THE HALF-WIDTH OF AN F-BAND IN SOLID SOLUTIONS OF ALKALI-HALIDE YSTALS WITH THE DEGREE OF THEIR IMPERFECTION.

a.Melik-Gaikazyan and E.K.Zavadovskaya.
tika i Spektrosk. (USSR), Vol. 9, No. 4, 516-17 (Oct., 1960).
Russian.

Reports that the half-width of the F-band rose with the degree imperfection (the number of Schottky and other defects) of l—RbCl solid solutions. Maxima of the half-width and the degree imperfection occurred at the same composition of 60% KCl. her binary alkali-halide solid solutions, such as KBr—KCl, haved similarly. [English translation in: Optics and Spectrosc. SA), Vol. 9, No. 4, 268-9 (Oct., 1960)].

A.Tybulewicz

14332 THE F-BAND HALF-WIDTH AND THE DENSITY OF F-CENTRES IN MONOCRYSTALLINE SOLID LUTIONS KCl—KBr.

Ya.Melik-Gaikazyan, M.N.Treskina and E.K.Zavadovskaya.
ptika i Spektrosk. (USSR), Vol. 9, No. 6, 782-4 (Dec., 1960).
Rusaian.

KCl—KBr crystals were grown by the Kyropoulos method and radiated with X-rays. The F-band half-width in the absorption ectrum and the number of Schottky defects (vacancies) had axima at compositions of ~ 80% KBr and ~ 70% KBr respectively. he number of F-centres (n_0) had a maximum at ~ 50% KBr and inima at ~ 20% and ~ 90% KBr. The value of n_0 was lower in Br—KCl solutions than in pure KBr or KCl, due to lower stability F-centres in solid solutions. [English translation in: Optics and ectrosc. (USA), Vol. 9, No. 6, 411-12 (Dec., 1960)].

A.Tybulewicz

14333 OPTICAL SATURATION OF F-CENTRE SPIN RESONANCE.

B.R.McAvoy, D.W.Feldman, J.G.Castle, Jr and R.W.Warren.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 618-20 (June 1, 1961).

The steady-state population difference and spin relaxation time were measured at 2.1°K during exposure to F-light in pure, γ-irradiated KCl crystals. The relaxation time was found to be proportional to the steady-state population difference for two intensities of the irradiating light. No preferential pumping was found.

J.E.Caffyn

14334 THEORY OF HOLE F-CENTRES IN ALKALI HALIDE CRYSTALS. T.I.Kucher.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 345-56 (1959).
In Ukrainian.

A previously developed method (Abstr. 3822 of 1957) is employed to calculate the energy and Ψ-function of certain states of a KCl crystal with the alkali ion missing and an excess hole. The hole and vacancy are assumed to form a hole F-centre. It is further assumed that the hole may be localized on the halide ions, converting them into an atom. The Ψ-function of the crystal is constructed like a linear combination of Faulk determinants constructed on ionic Ψ-functions. The latter are explicitly written for all six valence electrons of the halide ion, and for the atom themselves are represented in the form of a linear combination with three degenerate p-functions. The calculation shows that the ground state of the hole F-centre is completely symmetric. The energy of the optical dissociation on the transition of the hole from this state to the bottom of the hole band at $k(\pi/d, \pi/d, \pi/d)$, found in a Frank—Condon approximation, equals 2.76 eV, while the thermal dissociation is about 2 eV. The results are compared with the experimental data on V_1 centres.

14335 ON THE THEORY OF THE F-CENTRE. III. ATOMISTIC FORMULATION OF THE HAMILTONIAN OPERATORS AND STATIC ELECTRON—LATTICE COUPLING. M.Wagner.

Z. Naturforsch. (Germany), Vol. 16a, No. 4, 410-26 (April, 1961).
In German.

For Pt II, see Abstr. 11237 of 1961. Following the continuum approach, the electron—lattice interaction is here based on an atomic model and the effective mass of the defect electrons determined. The effect of the lattice ions is treated as a superposition of a point charge and a polarization dipole. Ionic polarization determines the motion of the defect electrons at any instant; this field possesses a singularity and necessitates a modification of the polarization rule. The Hamiltonian operator is explicitly derived for static equilibrium. Assuming a simple single-parameter wave-function, for which the superposition of a central and lattice-periodic symmetry is adequate in the operator, the ground-state of the F-centre is calculated to be −1.5 eV for potassium bromide.

G.F.J.Garlick

14336 COLOR CENTERS IN Cu-DOPED NaCl AND KCl CRYSTALS. K.Fukuda and T.Nakagawa.

Bull. Inst. chem. Res. Kyoto Univ. (Japan), Vol. 39, No. 2, 158-65 (March, 1961).

Cu-doped NaCl and KCl crystals, when irradiated by γ-rays from Co^{60} at room or dry ice temperature, showed optical absorption bands of colour centres associated with neutral Cu atoms and divalent Cu ions, while F-coloration was desensitized and V-type bands such as V_2 or V_3 were completely suppressed by the existence of Cu ions in these crystals.

14337 THERMAL BLEACHING OF F-CENTRES OF GAMMA-IRRADIATED KCl AT LOW TEMPERATURES.

N.Itoh and T.Suita.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1716-17 (Sept., 1960).

Thermal bleaching of F- and V-centres in KCl produced at liquid nitrogen temperatures by irradiation with gamma-rays (9.4×10^4 and 1.7×10^6 r) were measured for heating rates of 1 deg C/min. Sudden changes in bleaching rate were observed at 98, 116, 172, 250 and 278°K. These are qualitatively discussed.

J.E.Caffyn

14338 OPTICAL BLEACHING OF GAMMA-IRRADIATED KCl AT ROOM TEMPERATURE. N.Itoh and T.Suita.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2364 (Dec., 1960).

Fast and slow bleaching of F-centres with F-light in gamma-irradiated KCl (10^5-10^9r) at 18 and −25° C was measured. Two sorts of fast bleaching centres are distinguished one dependent and the other independent of the bleaching temperature. The latter saturates at $10^{16}/cm^3$ with increasing gamma-ray dose. At low dose rates only fast centres are produced at -25° C. J.E.Caffyn

14339 A-CENTRES IN POTASSIUM CHLORIDE CRYSTALS.

K.Kojima and N.Nishimaki.

J. Phys. Soc. Japan, Vol. 16, No. 1, 121-2 (Jan., 1961).

Bleaching experiments with addititively coloured KCl using off-peak F-light at temperatures down to -70° C are described and interpreted in terms of an electron trapping centre (A-centre). J E.Caffyn

14340 INTERACTION OF EXCITON WITH ELECTRON TRAPPING CENTERS IN ALKALI HALIDE CRYSTALS. III. EXCITON INDUCED PHOTOCONDUCTIVITY OF U CENTER.

M.Ueta, M.Hirai and M.Ikezawa.

J. Phys. Soc. Japan, Vol. 16, No. 3, 538-46 (March, 1961).

For Pt II see Abstr. 8917 of 1961. The photoconductivity of KCl and KBr crystals containing U centres was investigated as a function of the illuminating photon energy, in both the regions of U absorptions and the fundamental absorption bands of host crystals. The maximum conductivity occurs where the fundamental absorption starts. The photoconductivity curve is similar to the spectral distribution of the quantum efficiency of U → F conversion as reported previously. The wavelength of light which enhances the maximum conductivity shifts to the longer wavelength side if the U centre concentration is below 5×10^{16} cm^{-3}. This fact is in agreement with that of the quantum yield dependence on the concentration. The behaviour of the Br-ion band in KCl crystals upon the photoconductivity was also investigated and it was concluded that localized excitons which may be considered to be produced by photons absorbed in the Br band, have the same property as the free excitons in the host crystal so far as the effect on U centres is concerned.

14341 EVIDENCE FOR THE DOUBLE F MODEL OF THE M CENTER.

B.J.Faraday, H.Rabin and W.D.Compton.

Phys. Rev. Letters (USA), Vol. 7, No. 2, 57-9 (July 15, 1961).

Evidence is provided by optical absorption measurements on KBr, KBr : Ca, KCl and KCl : Sr irradiated at low temperatures by X-rays, the M-centre concentration so developed being proportional to the square of the F-centre concentration. From the probability of producing two adjacent F-centres, reasonable values of the M-centre oscillator strength are calculated. Other work on NaCl and LiF at room temperature (Abstr. 627 of 1955) gives the same relation between M- and F-centre concentrations, though here the F-centres, if randomly distributed, may interact over 6 or 7 lattice spacings. The R-centre, whose absorption varies approximately as the 1·5-th power of the M-centre absorption, may consist of M + F, or three F centres. S.T.Henderson

Radiation Effects

14342 EFFECTS OF ELECTRON BOMBARDMENT UPON INORGANIC SUBSTANCES OBSERVED IN AN ELECTRON MICROSCOPE.

H.de Souza Santos.

An. Acad. Brasil. Cienc., Vol. 32, No. 3-4, 333-40 (1960).

55 inorganic and organic substances were subjected to bombardment in an electron microscope and the morphological alterations correlated with phase changes and chemical transformations which the substances undergo with increase in temperature. The changes enabled the rise in temperature of the specimens to be estimated, reaching ~ 200° C under low intensity and as high as 400° C under normal conditions of operation. V.R.Switsur

14343 THE RANGE—ENERGY RELATIONSHIP FOR ATOMS IN CRYSTALLINE SILICON KNOCKED OUT INTO INTERSTITIAL SITES BY ELECTRON BOMBARDMENT.

B.Ya.Yurkov.

Fiz. tverdogo Tela (USSR), Sbornik [Supplement] II, 63-9 (1959).
In Russian.

Establishes a relationship between the energy received by a displaced silicon atom from a bombarding electron and the distance of this atom from its original site (now a vacancy). The relationship is derived from the data on annealing of defects produced in silicon by 0.7 MeV electrons (Abstr. 7524 of 1958). A.Tybulewicz

14344 THE BEHAVIOURS OF FREE RADICALS TRAPPED γ-IRRADIATED POLYETHYLENE.

H.Kashiwabara and K.Shinohara.

J. Phys. Soc. Japan, Vol. 15, No. 6, 1129 (June, 1960).

Samples of high-density Marlex 50 and low-density Sumikat were irradiated in vacuum at room temperature and examined b e.s.r. They both gave similar spectra from which the yield of f radicals as a function of radiation dosage, and the number of ra remaining after heating as a function of temperature were deter It is suggested that free radicals are trapped in the crystalline regions of the samples, and that they disappear on heating becau of the melting of the crystalline regions. J.M.B

14345 EFFECTS OF IONIC BOMBARDMENT OF SHORT DURATION ON METAL SINGLE CRYSTALS.

R.Castaing and B.Jouffrey.

C. R. Acad. Sci. (France), Vol. 252, No. 18, 2696-8 (May 3, 196
In French.

Thin gold foils were submitted to bombardment by argon io (energy 4 keV, current 2 A/mm^2) for times up to one second, an examined in the electron microscope. It was concluded that the bombardment had introduced a large number of stacking faults caused the previously-existing dislocations to vanish. This mechanism is believed to be responsible for the apparent uneve ness that occurs when thin metallic foils are prepared by ionic polishing. J.Th

14346 LOW ENERGY ION BOMBARDMENT OF GOLD.

D.G.Brandon and P.Bowden.

Phil. Mag. (GB), Vol. 6, 707-10 (May, 1961).

A preliminary report on the nature of subsurface damage produced in thin films of 99.998% purity Au by bombardment wit argon ions (A^+) having a maximum energy of 75 eV and a half-p width of 5 eV. R.F.

14347 FORMATION OF LATTICE DEFECTS UNDER THE ACTION OF THERMAL NEUTRONS ON IRRADIAT SILICON SINGLE CRYSTALS IN A NUCLEAR REACTOR.

M.V.Chukichev and V.S.Vavilov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1522-7 (May, 1961).
In Russian.

The mean number of displaced atoms produced by nuclear recoil on radiational capture of thermal neutrons by silicon is calculated to be 20 per cm^3 per 100 incident neutrons. In silico exposed in a heavy water reactor, the number of conduction ele rons, determined from the Hall coefficient is found to be about quarter the calculated number of displaced atoms. A comparis made between the number of defects produced in the reactor by and by thermal neutrons. [English translation in: Soviet Physic Solid State (USA)]. R.F.S.Hea

14348 AGGREGATION AND DISPERSAL OF RADIATION DAMAGE IN GRAPHITE.

W.N.Reynolds, P.A.Thrower and B.E.Sheldon.

Nature (GB), Vol. 189, 824-6 (March 11, 1961).

Crystals of natural graphite obtained from Ticonderoga cal were irradiated with doses of about 4.8×10^{20} $neutrons/cm^2$ at various temperatures in the range 150-650°C. Transmission ele micrographs are shown immediately after irradiation and after subsequent high-temperature annealing. Annealing of the low-temperature damage causes the defects to form clusters, the ef becomes marked at about 1000°C. Above about 1500°C the dama rapidly anneals out. The authors believe the effects they obser are caused by interstitial clusters. R.Bul

14349 PHOTOIONIZATION OF Ce^{3+} IN GLASS.

J.S.Stroud.

J. chem. Phys. (USA), Vol. 35, No. 3, 844-50 (Sept., 1961).

The photoionization of Ce^{3+} was investigated by determinin the optical absorption changes and the electron spin resonance changes that occur when cerium-containing silicate glasses are illuminated with ultraviolet light. The results are: (1) the roo temperature quantum yield of photoelectrons from Ce^{3+} is 0.1; (2) the optical absorption and the electron spin resonance bands caused by trapped photoelectrons are found; (3) a Ce^{3+} ion from which a fourth electron has been removed by photoionization is different from a Ce^{4+} ion.

4350 PARAMAGNETIC NITROGEN OXIDES IN IRRADIATED POTASSIUM HALIDES. C.Jaccard.

. Rev. (USA), Vol. 124, No.1,60-6 (Oct. 1, 1961).

In X-ray irradiated single crystals of KCl, KBr, and KI doped e melt with nitrate or nitrite, six triplets and one singlet bbserved in electron paramagnetic resonance between -190°C oom temperature. The trapping mechanism producing the es is indicated by the behaviour of the electron paramagnetic nance signal during optical or thermal release of free electrons a F centres) or holes (from Cl_2^-), and the chemical nature e centres by selective doping methods. In all three salts these have identified NO interstitials (anisotropic up to room erature, almost axial symmetry, principal paramagnetic axes 00], [011], and [0$\bar{1}$1] directions); NO in positive-ion vacancies ropic); and NO_3^{2-} in negative-ion vacancies (anisotropic below C, axial symmetry, axis in [111] direction). In KCl and NO_2^{2-} in negative-ion vacancies (anisotropic, axial symmetry, in [$\bar{1}$10] direction, visible below -125°C), and oxygen molecules otropic, almost axial symmetry, axes in [100], [011], [0$\bar{1}$1] tions, visible below -100°C) were identified. Information reing the bonding in the molecules was obtained. Two isotropic ets are not identified. The relative concentrations are rent in the various host crystals, and the line-width increases rding to the halogen nuclear moment.

351 CHANGES IN COPPER AND BORON SURFACES UNDER PARTICLE RADIATION. W.Marth.

gew. Phys. (Germany), Vol. 13, No. 5, 224-30 (May, 1961). rman.

Electron microscopic examination of Cu surfaces showed that irradiation by α-particles, surface roughness had markedly eased. The smoothing effect is attributed to volume diffusion erstitial atoms. Irradiation did not introduce any changes in y or electron diffraction lines. No spikes or pits were visible irradiation with heavy recoil atoms. Irradiation of B^{10} powder neutrons caused some sintering. J.Franks

PRECIPITATION AND IRRADIATION HARDENING IN IRON. bstr. 12652

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

352 ELECTRIC TRANSPORT IN INTERSTITIAL SOLID SOLUTIONS. D.F.Kalinovich.

verdogo Tela (USSR), Vol. 3, No. 4, 1117-21 (April, 1961). ssian.

According to most recent theories, the migration of a ituent in an alloy, placed in an electric field, may be caused nly by the field forces but also by forces due to the interaction een electrons and atoms. An analytical study is made of the ive parts played in this phenomenon by forces of both types g on the interstitial ions in various systems, and the effective es of C ions in γ-Fe are calculated from experimental data. ish translation in: Soviet Physics—Solid State (USA), Vol. 3, , 812-15 (Oct., 1961)]. M.H.Sloboda

353 DETERMINATION OF RESISTIVITY TENSOR AND HALL TENSOR OF ANISOTROPIC CONDUCTORS.

an der Pauw.

os Res. Rep. (Netherlands), Vol. 16, No. 2, 187-95 (April,

The resistivity tensor of an anisotropic conductor with respect arbitrarily chosen rectangular coordinate system can be ibed by six constants. It is shown that these six constants elated to the "sheet resistivities" of six plane-parallel samples linear equations. The plane-parallel samples may be of rary shape and cut in arbitrary but known directions. The effect can most generally be described by nine constants. For etermination of these nine constants only three such samples equired, combined however with three different orientations of agnetic induction.

14354 INVESTIGATION OF THE EFFECT OF SHORT-RANGE ORDER ON THE ELECTRICAL RESISTANCE OF CERTAIN BINARY ALLOYS.

A.H.Lisnÿk, S.H.Lytovchenko, D.A.Ursul and N.A.Savchenko.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 521-7 (1958). In Ukrainian.

Cu_3Au (an ordering alloy), Al—Zn with 20 atomic per cent of Zn (an aging alloy) and FeCr (an alloy with the formation of chemical compounds) were studied. The observed changes in the residual resistance of the Cu_3Au alloy, depending on the quenching temperature agree with the predictions of Smirnov and Krivoglaz's theory, in accordance with which the residual resistance rises with a decrease in the short-range order. There is a disagreement between the theory and the results obtained by the authors in the case of the system Al—Zn. The cause is probably to be found in the aging of this alloy during the very process of hardening and, particularly, at room temperature before the beginning of measurements. A dependence of the residual resistance on the quenching temperature was obtained for FeCr (50%Cr). The residual resistance of the FeCr alloy decreases with an increase in the quenching temperature if the alloy has been previously annealed for 5 hr at 1100°C, and remains constant if the alloy has been previously annealed for 200 hr at 1100°C.

THE TEMPERATURE DEPENDENCE OF RESIDUAL ELECTRICAL RESISTANCE IN ORDERING ALLOYS. See Abstr. 12653

14355 THE INFLUENCE OF AGING TREATMENT ON THE TEMPERATURE DEPENDENCE OF THE ELECTRIC RESISTANCE IN ALNICO 5 MAGNET. T.Fujiwara and T.Kato.

J. Phys. Soc. Japan, Vol. 15, No. 9, 1705 (Sept., 1960).

Experiments on the variation of resistance with temperature after ageing at different temperatures in the range 600°-800°C indicate that two mechanisms operate. Ageing at 600°C gives the best magnetic properties and is an order—disorder transformation; above 650°C the process is one of precipitation into more than one phase. C.A.Hogarth

14356 INVESTIGATION OF THE ELECTRICAL RESISTANCE OF CERIUM, LANTHANUM AND NEODYMIUM AT PRESSURES UP TO 250 000 Kg/cm².

L.F.Vereshchagin, A.A.Semerchan and S.V.Popova.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1059-61 (June 11, 1961). In Russian.

The variation of electrical resistance with pressure was found to have a minimum and maximum for each of the materials examined. These lay in the pressure interval from 50 000-100 000 kg/cm², the minimum occurring at the lower pressure. [English translation in: Soviet Physics—Doklady (USA)]. K.N.R.Taylor

14357 THE ELECTRICAL CONDUCTIVITY OF THE COBALT—MANGANESE SPINELS WITH ADMIXTURES OF LITHIUM, TITANIUM, AND COPPER OXIDES.

M.Ya.Kushnerev, V.R.Linde and S.Z.Roginskii.

Fiz tverdogo Tela (USSR), Vol. 3, No. 2, 384-94 (Feb., 1961). In Russian.

It is shown that the conductivity mechanism of certain complex spinels does not agree with Verwey's model (Abstr. 2331 of 1947). The valency state and the chemical composition of the components of the cations, not the structure, are the primary factors determining the electrical properties of the spinels [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 281-7 (Aug., 1961)]. N.Davy

14358 INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE ELECTRICAL RESISTANCE OF PLASTICALLY DEFORMED COPPER DURING COOLING.

V.H.Khotkevÿch and V.O.Pervakov.

Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 755-9 (1959). In Ukrainian.

The dependence was obtained for the range +20° to -196°C. The accretion of resistance caused by deformation (ΔR) on cooling the sample to the temperature of liquid nitrogen is about 10-15% less than the value at room temperature. The difference between the values of the coefficient $\alpha = dR/dt$ (where R is the resistance and t is the temperature) in deformed and annealed metals is increased during cooling. The dependence is of a reversible nature.

14359 DETERMINATION OF CONTRIBUTIONS TO THE RESIDUAL RESISTIVITY OF GALLIUM AT 4.2°K.

L.R.Weisberg and R.M.Josephs.

Phys. Rev. (USA), Vol. 124, No. 1, 36-40 (Oct. 1, 1961).

Resistivity measurements were made on single-cystal wires of high-purity gallium in the temperature range of 1.27° to 43°K, and also at 4.2°K on gallium with added impurities, and with varying wire diameter. The last measurements indicated the electron mean free path to be 1.2 mm at 4.2°K at a resistivity of about 3×10^{-22} e.s.u., implying that the effective number of free electrons per atom in gallium is 0.2. Diffuse surface scattering was found to be an important scattering mechanism in wires of high-purity gallium at 4.2°K, and its contribution to the ratio of resistivity at 4.2° to 295°K in a 1 mm diameter crystal is 1.5×10^{-5}. The temperature measurements indicated that no resistivity minimum occurs, and also that along the b-axis, the lattice scattering contributes 0.4×10^{-5} to the resistivity ratio. The effect of grain boundaries on the resistivity ratio is negligible. The presence of as little as 1 atomic p.p.m. of impurities such as Cu, Ag, Zn, Tl, Ge, Sn, Pb, and As can be detected by residual resistivity measurements.

14360 EFFECT OF PLASTIC DEFORMATION ON RESISTIVITY OF GOLD—PALLADIUM ALLOYS.

H.J.Logie, J.Jackson, J.C.Anderson and F.R.N.Nabarro.

Acta metallurgica (Internat.), Vol. 9, No. 8, 707-13 (Aug., 1961).

Reports the effect of plastic deformation on the resistivity of gold—palladium alloys of various atomic compositions. The resistivity was found to decrease on plastic strain for alloys containing between 10 and 60 at.% palladium. The other alloys in the series showed an increase in resistivity on plastic extension. The experiments were performed at the temperature of liquid nitrogen. The annealing out of this resistivity change at room temperature, and the effect of extending the alloys at room temperature, were studied qualitatively. Two theoretical explanations are investigated. The first, which depends on the local shifts of Fermi level produced by the deformation potential round a dislocation, predicts effects similar to those observed. The second, based on the suppression of s—d scattering in a stacking fault, finds on independent support.

14361 THE SURFACE IMPEDANCE OF NORMAL AND SUPERCONDUCTING INDIUM AT 3000 Mc/s. P.N.Dheer.

Proc. Roy. Soc. A (GB), Vol. 260, 333-49 (March 7, 1961).

Measurements have been made of the surface resistance and reactance of cylindrical single crystals of normal and superconducting indium at a frequency of about 3000 Mc/s. The absolute value of λ_0, the penetration depth at 0°K, is found to be $(4.3 \pm 0.2) \times 10^{-6}$ cm, in good agreement with the prediction of the theory of Bardeen, Cooper and Schrieffer (1957), and the temperature variation also agrees rather well, but not perfectly. Only slight evidence is found for the non-tensorial anisotropy of λ_0 expected on the basis of Pippard's non-local theory, and it is argued that the shortness of the coherence length reduces the magnitude of non-tensorial effects. The temperature variation of the superconducting resistance is found to be similar to that observed by Pippard (1950) in tin at 9400 Mc/s. The data provide evidence for the similarity in the high-frequency behaviour of superconductors suggested by Faber and Pippard (Abstr. 8790 of 1955). As expected, the surface resistance and reactance in the normal state show marked non-tensorial anisotropy. From the resistance the area of the Fermi surface in indium is estimated to be 0.93 of the area of a free electron sphere holding 3 electrons per atom.

14362 ANISOTROPY OF RESISTIVITY IN IRON AND DILUTE SILICON-IRON.

E.Tatsumoto, K.Kuwahara and H.Kimura.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 359-65 (Oct., 1960).

The anisotropy coefficients ρ_1 and ρ_2 were measured for pure Fe and a 1.08% Si—Fe alloy between room temperature and the Curie point. E.P.Wohlfarth

14363 CONDUCTION ELECTRONS IN PSEUDONICKEL ALLOYS FROM HALL DATA.

E.R.Sanford, A.C.Ehrlich and E.M.Pugh.

Phys. Rev. (USA), Vol. 123, No. 6, 1947-51 (Sept. 15, 1961).

The two Hall coefficients and resistivity of four Ni—Cu—Fe alloys having 28 electrons per atom, with Ni content from 97 to 70 at. %, were measured at 20°K, 77°K, and room temperature using fields up to 3.1 Wb/m². R_0 is found to increase, with decreasing temperature for all compositions, and also to increase with decreasing Ni content for each of the three temperatures measured. The effective number of conduction electrons calculated from the R_0's measured at low temperatures is found to fall smoothly from the anomalous peak at pure Ni to about 0.3 at 70% Ni, in agreement with the predictions of the four-band model. A short summary of the considerable evidence supporting this model is given. The
extraordinary Hall coefficient, R_e, is negative at all temperatu
for the three samples richest in Ni, being increasingly negativ
the Ni content is lowered. On the other hand, the 70% Ni—20%
Cu—10% Fe alloy has positive extraordinary Hall coefficients
temperatures. The behaviour of R_e obeys none of the variousl
proposed theoretical relations.

14364 ON THE RESISTANCE ANOMALY OF DILUTE ZI ALLOYS AT LOW TEMPERATURES.

Y.Muto

J. Phys. Soc. Japan, Vol. 15, No. 11, 2119-20 (Nov., 1960).

The electrical resistivity of dilute zinc alloys containing
Mn (0.01 to 0.12 at.%) and Cr (0.01 and 0.10 at.%) has negativ
temperature coefficients below 4.2°K and a resistance minimu
above 4.2°K. A Zn—0.05 at.% Sn alloy shows no such anomalo
behaviour. It is suggested that in alloys containing transition
metals the anomalous behaviour is due to interactions betwee
conduction electrons and magnetic ions. H.M

14365 TRANSPORT PROPERTIES OF THIN METALLIC FILMS.

M.J.Baines.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 3, 606-22 (July,

In using the Boltzmann equation to calculate the transport
properties of thin metallic films, it is usually assumed that a
of relaxation exists for the scattering in the film which is the
as for the bulk metal, although this is only strictly justified in
ideal case of isotropic scattering. The correct Boltzmann equ
in the case of elastic scattering, when the cross-section depe
the angle of scatter, is set up and possible methods of solutio
discussed. The equation is solved for a simple anisotropic sc
ing law and the electrical resistivity and thermoelectric powe
found to depend upon two parameters which are measures res
ively of the thickness of the film and the anisotropy of the sca
mechanism. The numerical results for the electrical resistiv
however, differ only slightly from those given by the one-para
formula obtained when a time of relaxation is assumed to exis

14366 A CONTRIBUTION TO THE STUDY OF THE ELECTRICAL AND THERMOELECTRICAL PROP OF THIN FILMS OF COBALT.

F.Savornin.

Ann. Phys. (France), Vol. 5, No. 9-10, 1355-99 (Sept.-Oct., 19

In French.

Films of cobalt were prepared by evaporation in vacuo; t
growth of crystallinity was measured by electron diffraction a
correlated with the growth of electrical resistivity and therm
electric power. M.A.

14367 ELECTRICAL CONDUCTIVITY AND HALL EFFE THIN FILMS OF COBALT.

H.Daridon and A.Colombani.

C.R. Acad. Sci. (France), Vol. 252, No. 25, 3992-4 (June 19, 1

In French.

Resistivity (from 0 to 500°C) was measured on films fro
100 to 1000 A thick. Reversible changes in ΔR/ΔT were foun
between 150 and 200°C: these are probably caused by hexago
cubic structural transformations. The Hall effect at room te
ture was also measured. M.A.

14368 ON THE CONDUCTIVITY OF THIN Pb FILMS DEPOSITED AT LOW TEMPERATURES.

L.Constantinescu-Mociutchi and E.Ioniscu.

Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 3, 541-55 (1960

In Roumanian.

The conductivity of thin films of lead, deposited at -150°
was studied by observing the temperature changes of the elec
resistance and the variation of surface resistivity with thickn
Layers thinner than 150 A [$R_i < 10^2\ \Omega$] had within the temper
range -150° to +200°C a negative thermal coefficient of resis
The metallic behaviour clearly appeared in the case of thicke
films, in the T_m domain. The structure variation of films wi
increasing temperature was explained with the help of two pr
The ordering of the Pb atoms in the lattice, and the migratio
lead atoms on the backing plate. After T_m, the process of m
tion was preponderant, so that in this domain the thermal ene
was sufficient for the migration of the atoms (in conformity w
the Lennard-Jones theory, 1937).

ELECTRICAL PROPERTIES OF P-TYPE CdTe CRYSTA
See Abstr. 12445

369 ANISOTROPY OF THE MAGNETOELECTRIC EFFECT IN Cr_2O_3.

V.J.Folen, G.T.Rado and E.W.Stalder.
Rev. Letters (USA), Vol. 6, No. 11, 607-8 (June 1, 1961).
he temperature dependence of both the perpendicular and
lel magnetoelectric parameters was obtained for Cr_2O_3 in the
n of 100 to 300°K. The parameters were obtained by
uring the induced magnetization associated with an applied
ic field and using the theory of Dzyaloshinskii (Abstr. 11907
0). The perpendicular parameter, $\alpha_{\perp}$, has a maximum at
. and decreases monotonically to zero at 306°K (Néel
erature is 307°K), while $\alpha_{\parallel}$ is zero at 100°K increases to a
num at about 270°K and then also decreases to zero at 306°K.
ifferent temperature dependences result in a large anisotropy
magnetoelectric effect. Measurements as a function of
ed electric field demonstrate a linear dependence as predicted
yaloshinskii. P.E.Seiden

370 MECHANISM OF THE MAGNETOELECTRIC EFFECT IN AN ANTIFERROMAGNET.

G.T.Rado.
. Rev. Letters (USA), Vol. 6, No. 11, 609-10 (June 1, 1961).
The temperature dependence of the magnetoelectric suscept-
ies of Cr_2O_3 (described in the preceding abstract) were
ed to the antiferromagnetic susceptibilities by consideration
ictitious magnetic field produced in the material by the
ed electric field. Choosing the following reasonable form for
ctitious field h_z, $h_z \sim E_z\langle S_z\rangle_{av}$, where E_z is the applied
ric field and $\langle S_z \rangle_{av}$ is the thermal average of the expecta-
value of the z-component of the ionic spin, good agreement
tained between magnetoelectric and antiferromagnetic
eptibility data. The physical origin of the effect is attributed
listortion of the electronic cloud about the magnetic ion by the
ric field and a transmittal of this distortion to the spins by the
-orbit coupling thereby inducing a magnetization. A calculation
l on this reasoning gives a result consistent with the experi-
al data. P.E.Seiden

371 GALVANOMAGNETIC TENSORS OF CUBIC CRYSTALS.

A.Esteve Pastor and F.Garcia Moliner.
teal Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 7-8, 165-74.
-Aug., 1960). In Spanish.
Standard group-theoretical methods are used to work out
cit expressions for the galvanomagnetic (magnetoelectric)
rs of crystals with Laue symmetries O_h and T_h. The calcula-
are carried up to fourth power in magnetic field strength.
group characters corresponding to totally symmetric tensors
vorked out using a direct method. Some experimental aspects
iscussed.

372 AN APPARATUS FOR THE INVESTIGATION OF GALVANOMAGNETIC EFFECTS UNDER HYDRO-
IC PRESSURE.

A.A.Averkin and V.N.Bogomolov.
tverdogo Tela (USSR), Vol. 3, No. 2, 627-9 (Feb., 1961).
ssian.
Describes an apparatus for measuring the Hall effect and
etoresistance of semiconductors and other materials at
pressures. The magnetic field is applied between two poles,
n the pressure vessel, separated by a non-magnetic ring
the specimen is placed. Results are given for measurements
germanium sample at three different temperatures with
sures up to 1.5×10^4 kg/cm². The pressure dependence of
nergy gap is found to be 5.2×10^{-6} eV (kg/cm²)$^{-1}$. [English
lation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2,
2 (1961)]. K.N.R.Taylor

373 GALVANOMAGNETIC EFFECT IN FERRITES IN THE REGION OF THE CURIE POINT.

K.Zabeta.
tverdogo Tela (USSR), Vol. 3, No. 3, 856-60 (March, 1961).
ssian.
Measurements of galvanomagnetic effects near the Curie point
liscussed. Assuming the independence of the activation energy
ectrical conduction on the magnetic field strength, it is shown
he division of the change of the electrical resistance into
, corresponding to (a) an isothermal change in the field and
a change in temperature, does not depend on the path but only
e initial and final states. Both the isothermal and adiabatic
ges are shown to be proportional to $H^{2/3}$. In the Mn-Zn ferrites
hange in resistance due to the magnetocaloric rise in tempera-
is equal in value to the longitudinal isothermal galvanomagnetic
t. This enables one to determine experimentally the two
onents of the longitudinal adiabatic galvanomagnetic effect.
[English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 624-6 (Sept., 1961)]. N.Davy

14374 GALVANOMAGNETIC COEFFICIENTS OF SINGLE-CRYSTAL TELLURIUM.

A.Nussbaum and R.J.Hager.
Phys. Rev. (USA), Vol. 123, No. 6, 1958-64 (Sept. 15, 1961).

The twelve galvanomagnetic coefficients of tellurium crystals grown by the Czochralski method were measured over the temperature range 77°–300° K. The results of these measurements plus previous measurements at 4.2° K and a determination of the effect of pressure on one of the Hall coefficients are combined with symmetry characteristics to postulate an energy band structure. This structure differs from those previously proposed on the basis of tight-binding methods or by simple applications of group theory.

14375 THE DIRECTION DEPENDENCE OF PHYSICAL PROPERTIES OF CRYSTALS, PARTICULARLY GALVANO- AND THERMOMAGNETIC EFFECTS.

H.Bross.
Z. Naturforsch. (Germany), Vol. 15a, No. 10, 859-74 (Oct., 1960).
In German.

Various physical properties may be described by tensors, which in turn depend on a vector quantity. A method is developed which determines the direction dependence of these tensors in terms of the crystal symmetry. Scalar functions are used as a starting point, which are invariant under symmetry operations of the individual crystal classes. Tensors of the required order can be derived by suitable differentiation of these scalar functions. The general form of the scalar function is given for the 32 crystal classes. A phenomenological theory of galvano- and thermomagnetic effects is given as an example of tensors derived by this method.
R.Parker

14376 THE MAGNETORESISTANCE IN ZINC-MANGANESE FERRITES IN THE VICINITY OF THE CURIE POINT.

K.Závěta.
Czech. J. Phys., Vol. 11, No. 6, 424-38 (1961). In Russian.

The paper describes an exact method for measuring the adiabatic and isothermal magnetoresistant effects in ferrites. It gives the results of studying the temperature dependence of the magnetoresistant effect, which is negative near the Curie point in ferrites and the temperature dependence of which has a maximum of absolute values in T_c. It is also shown that the pronounced maximum of the adiabatic magnetoresistant effect is to a certain extent caused by the magnetocaloric effect. When measuring the dependence of the magnetoresistant effect on the field strength for a temperature equal to T_c, certain small deviations from the theoretically assumed dependence were found; the influence of different factors on these deviations is discussed and a proposal for their explanation is given in analogy to the results known for metals.

14377 THE EFFECT OF CURRENT ELECTRODES ON MAGNETORESISTANCE.

Yu.I.Gorkun.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 236-42 (Jan., 1961).
In Russian.

Considers the dependence of the measured magnetoresistance on the geometry of a sample and the positions of the probes on it, allowing for the short-circuiting effect of the current electrodes. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 1, 173-7 (July, 1961)] A.Tybulewicz

14378 ANGULAR DEPENDENCE OF MAGNETORESISTANCE IN HgSe.

T.C.Harman.
J. appl. Phys. (USA), Vol. 32, No. 9, 1800-1 (Sept., 1961).

The magnetoresistance of HgSe at 78°K was measured as a function of angle between current direction and magnetic field direction. The results are consistent with a model involving a very nearly spherically symmetric conduction band. M.A.Taylor

14379 OSCILLATORY MAGNETORESISTANCE IN N-TYPE PbTe.

Y.Kanai, R.Nii and N.Watanabe.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1717 (Sept., 1960).

Preliminary observations of oscillatory magnetoresistance effect at 4.2° K, without anomalous Hall effect are reported.
G.C.Williams

14380 THE QUADRATIC MAGNETORESISTANCE EFFECT IN MONOCRYSTALLINE MANGANESE FERRITE.

A.V.Zalesskii.
Kristallografiya (USSR), Vol. 4, No. 6, 867-72 (Nov.-Dec., 1959).
In Russian.

Disks cut from $MnFe_2O_4$ monocrystals, containing 6% Mn_3O_4, were used to measure the longitudinal magnetoresistance effect along [100], [110], and [111], and to record rotation patterns for the transverse effects in the (100), (110), and (111) planes. The anisotropy in the quadratic effect is described accurately by the formula for quadratic effects in cubic ferromagnetics; the constants are $h_{100} = 4.25 \times 10^{-3}$ and $h_{111} = 0.9 \times 10^{-3}$. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 822-7 (June, 1960)].

14381 STUDY OF THE LOW-TEMPERATURE TRANSFORMATION IN A MANGANESE FERRITE CRYSTAL.

K.P.Belov and S.A.Nikitin.
Kristallografiya (USSR), Vol. 5, No. 5, 726-31 (Sept.-Oct., 1960).
In Russian.

In the region of −75°C, single-crystal manganese ferrite was found to exhibit an anomalous temperature behaviour of electrical resistance and magnetoresistive effect, evidently associated with the existence of a low-temperature transformation. It was found that the electrical properties and magnetic anisotropy vary less sharply on transformation in the case of manganese ferrite than in that of magnetite. On the basis of an estimate of the value of the activation energy, it is assumed that the nature of the low-temperature transformation is evidently associated with an exchange of electrons between the manganese ions. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 694-8 (March-April, 1961)].

14382 QUANTUM THEORY OF MAGNETORESISTANCE. I. LOW FIELDS. R.B.Stinchcombe.

Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 275-92 (Aug., 1961).

The conventional treatment of magnetoresistance is based upon the Boltzmann equation for a distribution function f(k), and an equation which gives the average current in terms of f(k). With the usual definition of f(k) neither equation is exact: the derivation of the Boltzmann equation requires $\omega\tau < 1$, where ω is the cyclotron frequency and τ is the relaxation time. In this paper a representation is proposed which exploits the properties of homogeneous systems in a uniform magnetic field. The author redefines f(k) as the diagonal element of the density matrix in the new representatation. Then the usual equation for obtaining the current becomes exact. Proceeding fron the equation of motion of the density matrix a weak-coupling derivation of the Boltzmann equation is then given in the manner used by Kohn and Luttinger (Abstr. 3474 of 1957) for field-free systems. The derivation is restricted to the case of non-interacting carriers elastically scattered by impurities or lattice vibrations, and moving in a lattice which in the absence of the magnetic field gives rise to non-overlapping bands. The conductivity yielded by this method is found to be accurate as long as $\hbar\omega$, $\hbar/\tau$ are small compared with the Fermi energy, and $\hbar\omega$ is less than the thermal energy. The condition $\omega\tau < 1$ does not arise.

CONDUCTION ELECTRONS IN PSEUDONICKEL ALLOYS FROM HALL DATA. See Abstr. 14363

14383 HALL EFFECT IN DILUTE Pd—Co—H ALLOYS. J.P.Burger.

C.R. Acad. Sci. (France), Vol. 252, No. 24, 3763-5 (June 12, 1961).
In French.

Contributions to the Hall effect from ferromagnetic magnetization in Pd—Co alloys and from paramagnetic magnetization in Pd—Co—H alloys are clearly recognizable. M.A.Taylor

14384 SIGN REVERSAL OF HALL COEFFICIENTS AT LOW TEMPERATURES IN HEAVILY COMPENSATED p-TYPE GERMANIUM. H.Yonemitsu, H.Maeda and H.Miyazawa.

J. Phys. Soc. Japan, Vol. 15, No. 9, 1717-18 (Sept., 1960).

This is observed at 5°K in germanium heavily doped (~ 40%) with Ga and Sb. Below 5°K the Hall coefficient was not dependent on T. G.C.Williams

14385 PHOTOCONDUCTIVE HALL EFFECT IN POTASSIUM BROMIDE. M.Onuki.

J. Phys. Soc. Japan, Vol. 16, No. 5, 981-8 (May, 1961).

An a.c. method was employed to investigate the mobility of the conduction electrons in KBr under the space-charge-free condition at temperatures between 80°K and room temperature. In this experiment white light was used to illuminate the specimen to enhance the conductivity. The mobility which depends on temperature was found to be inversely proportional to the mean density of phonons excited in the crystal. This fact suggests that the mobility is determined mainly by the scattering of the optical mode of lattice vibration. Using the Low and Pines formula (Abstr. 5 of 1955), the following values were obtained: Effective mass bare conduction electron, m* = 0.23 m; effective mass of the polaron, m_p = 0.33 m; strength of interaction between the ele and the polarization, α = 2.56; where m is the free electron

14386 TEMPERATURE DEPENDENCE OF THE HALL E IN $MnAu_2$. V.N.Novogrudskii and I.G.Fakidov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 76-8 (Jan., 196
In Russian.

It is shown that the ordinary Hall effect is supplemented additional effect in the antiferromagnetic temperature range. suggested that this additional effect is caused by the presence high magnetic susceptibility. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 53-4 (July, 1961)].

14387 "AMBIELECTRONIC" THERMOMAGNETIC EFFE AND THE MECHANISM OF ELECTRONIC RELAX IN THE III-V COMPOUNDS. M.Rodot.

C.R.Acad. Sci. (France), Vol. 252, No. 17, 2526-8 (April 24,
In French.

A calculation is made of the Nernst effect when the elect occupy two partially superposed bands. Evidence is presente that this may be the case in GaAs and GaSb. For InAs, the la discrepancy between theory and experiment at high temperatu may on the other hand be removed by considering a screened interaction with the optical vibrations. L.Pi

14388 THERMAL ACTIVATION ENERGY OF THE DAR CONDUCTIVITY OF ORGANIC COMPOUNDS.

A.T.Vartanyan and L.D.Rozenshtein.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 713-22 (March, 196
In Russian.

The activation energy was obtained from the temperatur dependence of the dark conductivity of solid layers of a serie organic dyes and uncoloured compounds. It was shown that th values agree with the short-wavelength edge of the phosphore band at low temperatures and with the long-wavelength drop o spectral absorption curves of the corresponding substances. free carriers are thus thought to be created by a singlet—sin electron transition. [English translation in: Soviet Physics— State (USA), Vol. 3, No. 3, 520-6 (Sept., 1961)]. D.J.

14389 ON THE DARK CURRENT CONDUCTIVITY OF POTASSIUM IODIDE CRYSTALS CONTAINING R' CENTERS. V.Hovi and E.Mäntysalo.

Ann. Acad. Aci. Fennicae A VI (Finland), No. 66, 13 pp. (1960)

The dark current conductivity of some additively coloure blue KI crystals was investigated at temperatures between 77 and 298.7°K. These crystals contained intially 6.0×10^{17} F- per cm^3. This figure was obtained by means of optical absor measurements. During heating for about 15 minutes at 723°K centres were transformed almost completely into R'-centres small number of the F-centres was observed to be excited to higher energy level which corresponds to the K-band. For a crystal containing R'-centres the dark current conductivity a 298.7°K and at field strength of 500 V cm^{-1} was measured as 3.0×10^{-12} ohm^{-1} cm^{-1}, whereas the same quantity of an unc KI crystal under the same conditions was only 6.5×10^{-15} oh cm^{-1}. At 77.3°K, however, the dark current conductivity of a coloured crystal decreased to the value of 2.8×10^{-15} ohm^{-1} A considerable increase of the conductivity with increasing fi strength was also found for a coloured preparation. Further when a continuous electric current flowed through a coloured crystal, a transient increase of the dark current conductivity function of time was observed.

14390 ON THE GYULAI—HARTLY EFFECT IN SINGLE CRYSTALS OF POTASSIUM IODIDE AT TEMPEF TURES BETWEEN 77 AND 297°K.

V.Hovi, E.Mäntysalo and P.Ketolainen.
Ann. Acad. Sci. Fennicae A VI (Finland), No. 82, 16 pp. (1961)

The increase of the dark current, caused by plastic defo in potassium iodide crystals was measured at temperatures 77 and 297°K. The increase of the dark-current conductivity as Gyulai—Hartly effect (1928), was found to be independent o temperature. The maximum current induced by the deformat decreased in repeated deformation experiments, as also has

erved at higher temperatures. At 77°K a charge flow in the
osite direction to the Gyulai–Hartly effect was found when the
l was removed. On further deformation, a charge flow in the
ve direction was observed, instead of the expected Gyulai–Hartly
ct. As a result of successive deformation experiments saturation
rents associated with work hardening were measured. Potassium
de crystals containing R'-centres did not show any Gyulai–Hartly
ct at 297°K.

14391 EFFECT OF IRRADIATION ON THE ELECTRICAL AND OPTICAL PROPERTIES OF LITHIUM FLUORIDE. ELECTRICAL CONDUCTIVITY OF NON-IRRADIATED LITHIUM UORIDE SINGLE CRYSTALS. P.Bergé.

l. Soc. Franc. Mineral. Crist., Vol. 83, No. 1-3, 57-62 (Jan.-
rch, 1960). In French.

The conductivity, measured from 20° to 560° C, is due to holes
uced by divalent impurity atoms. The associated activation
rgy is 0.7-0.8 eV. M.A.Taylor

4392 THE DEPENDENCE OF CURRENT ON TEMPERATURE AND VOLTAGE IN PRE-BREAKDOWN FIELDS IN r SINGLE CRYSTALS.

.Afanas'eva, V.S.Vinogradov and E.A.Konorova.

. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 1, 66-74; Disc. 91-3
60). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003
1960). Constant voltages were applied to KBr crystals. Above
ertain critical value of the voltage, field emission of electrons
urred at the cathode. These electrons were first trapped to
m a space charge, which prevented further field emission. Then
y were liberated from traps by thermal fluctuations. The
erated electrons were responsible for the observed currents.
A.Tybulewicz

4393 ELECTRICAL CONDUCTIVITIES OF α- AND β-PHTHALOCYANINE. K.Wihksne and A.E.Newkirk.

hem. Phys. (USA), Vol. 34, No. 6, 2184-5 (June, 1961).

The two crystal modifications have different conductivities:
phthalocyanine has a higher conductivity with an activation
rgy of 0.25 eV, while β-phthalocyanine has a conductivity which
10^8 times lower and an activation energy of 0.9 eV. The
eversible transition from α to β by heating can be followed
ctrically. J.A.Bornmann

4394 ELECTRICAL CONDUCTIVITY OF SYNTHETIC CRYSTALLINE ZEOLITES.

.Freeman, Jr and D.N.Stamires.

hem. Phys. (USA), Vol. 35, No. 3, 799-806 (Sept., 1961).

The electrical conductivity of anhydrous Linde zeolite types A,
and Y in various cationic forms was measured between 20 and
°C. The conductivity is ohmic, essentially noncapactive, and
pears to be strictly ionic with unusually low activation energy.
om the effect of zeolite channel size, type of cation and cation
nsity on ΔH, ΔG, and ΔS for the conduction process, some con-
usions as to the zeolite internal structure and surface energy
re obtained. The heterogeneity of the internal surface energy
und by the measurement of adsorption heats is discussed in the
ht of these conclusions.

395 ELECTRICAL RESISTIVITY OF FERROMAGNETIC CHROMIUM DIOXIDE. B.Kubota and E.Hirota.

Phys. Soc. Japan, Vol. 16, No. 2, 345-6 (Feb., 1961).

A plot of resistance versus temperature for four samples
CrO_2 as compressed powders had an anomalous peak at the
rie temperature (116° C) but on either side of this temperature
resistance decreased with increasing temperature. The
rmoelectric powers were negative. The conduction is attribut-
to interstitial Cr ions. J.A.Bornmann

14396 ANISOTROPY IN THE ELECTRICAL CONDUCTIVITY OF A MONOCRYSTAL OF $Li_2SO_4 \cdot H_2O$.

M.Gurevich and I.S.Zheludev.

istallografiya (USSR), Vol. 5, No. 5, 805-6 (Sept.-Oct., 1960).
Russian.

The conductivity was measured by means of high-range
mmeters at field strengths of from 0.5 to 12 000 V/cm at
nperatures of from 15° to 80°C (each temperature constant) in
y air on previously dried specimens. The specimens showed no
gns of loss of water at the end of the measurements. The
easurements along X, Y, and Z were made on small cubes cut -
om the crystals, and on appropriately cut plates. There was no deviation from Ohm's law within the ranges of temperature and voltage used. The surface conductance in moist air (60-70% relative humidity) was some six to ten times the volume conductance, and showed only slight anisotropy. The anisotropy in the conductivity followed the crystallographic symmetry (monoclinic); X, Y, and Z are crystallographically all distinct. The conductivity was greatest along Y (the pyroelectric axis). The microhardness also shows anisotropy: 17.55 kg/mm² along X, 48.90 along Y, and 26.40 along Z. The breakdown strength is over 100 kv/cm in all three directions. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 767-8 (March-April, 1961)].

14397 PROPERTIES OF GLASSES IN THE SYSTEM $CaO-B_2O_3-Al_2O_3$. I. THE D.C. CONDUCTIVITY AND STRUCTURE OF CALCIUM BOROALUMINATE GLASSES.

A.E.Owen.

Phys. Chem. Glasses (GB), Vol. 2, No. 3, 87-98 (June, 1961).

Measurements are reported of the d.c. resistivity in glasses of the system $CaO-B_2O_3-Al_2O_3$ (the Cabal glasses). The structure of these ternary glasses is discussed in the light of the various theories of the borate anomaly and it is found that the predictions of Abe's screening theory are best in accord with the observations of the trend of conductivity with composition in this series of glasses. From the assumptions made in applying Abe's hypothesis it would follow that the borate and aluminate parts of the Cabal glasses are segregated. The mechanism of conduction is also discussed and it is suggested that this proceeds by the field-induced drift of oxygen ions by a mechanism involving interstitial positions. Heat treatment in or below the transformation range is shown to have practically no effect on the d.c. resistivity of the Cabal glasses.

Semiconductors

14398 CHANGES IN SURFACE RECOMBINATION CAUSED BY SORPTION OF WATER MOLECULES. G.Dorda.

Czech. J. Phys., Vol. 11, No. 6, 406-15 (1961).

A study was made of the influence of the percentage relative humidity in the surrounding atmosphere on the surface recombination of germanium at room temperature. The surface conductivity and a.c. field effect were measured as a function of the relative humidity at the same time as the effective lifetime was determined. The cyclically varying humidity was changed in the limits of 0.5 and 80%. A comparison between the results of the surface recombination and the field effect gave the values of the energies, concentration and cross-section for the trapping of holes and electrons of the fast states. Analysis was based on the assumption that all fast centres and not only of one kind contribute to recombination. It was proved that the hysteresis of the dependence of s on φ_s during the humidity cycle can be explained on the basis of changes in concentration of all fast states due to the sorption of water molecules in the oxide layer.

14399 ON THE DETERMINATION OF THE POSITION OF THE ENERGY LEVEL OF SURFACE RECOMBINATION CENTRES. S.Koc.

Czech. J. Phys., Vol. 10, No. 8, 579-83 (1960).

A detailed analysis of the dependence of the surface recombination velocity s on the surface potential Φ_s leads to the conclusion that the position of the surface recombination level with respect to the centre of the energy gap $E_t - E_i$ does not coincide with the value $q\Phi_s^*$, while the surface recombination velocity s decreases to half its maximum value. The difference between the two quantities points corresponding to the values $s = \frac{1}{2}s_{max}$ is greater than 8kT.

14400 ELECTRON IMPACT IONIZATION. THE PROBABILITY OF OCCUPYING STATES AFTER IONIZATION.

M.Miasek.

Czech. J. Phys., Vol. 10, No. 8, 584-94 (1960).

The probability function of occupying states with a definite energy in the conduction band after collision in the process of electron impact ionization is calculated. The valence band is assumed of finite width. Several cases of the primary energy and the effective mass in the valence band are examined.

14401 DIFFUSION OF THE EXCESS CURRENT CARRIERS IN AN ANISOTROPIC CUBIC CRYSTAL IN THE PRESENCE OF A MAGNETIC FIELD. V.N.Dobrovol'skii.

Fiz.tverdogo Tela (USSR), Vol. 3, No. 5, 1574-80 (May, 1961).
In Russian.

The theory of the drift and diffusion proper of the excess current carriers in an anisotropic cubic crystal placed in a weak magnetic field is discussed. The results obtained are compared with those obtained for the isotropic case by the present author in 1960. The possibility of the experimental determination of the phenomenological parameters of the theory is pointed out. [English translation in: Soviet Physics—Solid State (USA)]. N.Davy

14402 PROPERTIES OF SEMICONDUCTORS WITH A [BRILLOUIN ZONE] EXTREMUM LOOP. II. MAGNETIC SUSCEPTIBILITY IN A FIELD PERPENDICULAR TO THE PLANE OF THE LOOP.

I.I.Boiko and É.I.Rashba.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 8, 1874-83 (Aug., 1960).
In Russian.

The theory of cyclotron resonance in such semiconductors was given in Pt I [Ibid., Vol. 2, No. 6, 1224 (June, 1960). English translation in: Soviet Physics - Solid State (USA), Vol. 2, No. 6, 1109-1122 (Dec., 1960)] where it was pointed out that such a structure probably occurs in the hexagonal CdS. A number of limiting formulae are obtained for the monotonic part of the susceptibility when there is or is not degeneracy of the electron gas. Oscillations of the susceptibility, related to the presence of regions with negative effective mass and the existence of two adjacent Fermi surfaces, are studied. The latter situation leads to characteristic beats, which should also be present in other crystals without a centre of symmetry. [English translation in: Soviet Physics—Solid State (USA), Vol. 2, No. 8, 1692-99 (Feb., 1961)]. R.Berman

14403 PROPERTIES OF SEMICONDUCTORS WITH A [BRILLOUIN ZONE] EXTREMUM LOOP. III. BEHAVIOUR IN A MAGNETIC FIELD, PARALLEL TO THE PLANE OF THE LOOP.

É.I.Rashba and I.I.Boiko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1277-89 (April, 1961).
In Russian.

Deals with cyclotron and combinational resonance and with magnetic susceptibility, in a magnetic field parallel to the plane of the loop. It should be easier to observe cyclotron resonance in the parallel case, but harder to observe combinational resonance. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 927-34 (Oct., 1961)]. R.Berman

14404 THE STATISTICS OF THE RECOMBINATION OF ELECTRONS AND HOLES AT IMPURITY CENTRES IN SEMICONDUCTORS.

Yu.V.Gulyaev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 382-3 (Feb., 1960).
In Russian.

Capture coefficients are considered for the case in which several excited states of a trap correspond to one charge state. It is assumed that the transition times between the excited states of one charge state are much less than the transition time between different charge states, so that an effective Fermi level may be introduced for each charge state. This enables an expression for the lifetime of the pairs to be written down. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 279-80 (Aug., 1961)]. K.G.Major

14405 MAJORITY CARRIER MAGNETOSURFACE EFFECT.

R.D.Larrabee.
J. appl. Phys. (USA), Vol. 32, No. 10, 2019-26 (Oct., 1961).

In semiconductors with extremely low majority carrier densities, the conductivity of the surface space charge region can be very different from that of the bulk. This paper demonstrates that the conductivity of this surface space charge region can be materially altered by the application of a magnetic field perpendicular to the direction of current flow. A tentative prototype model of this effect is presented which not only illustrates the important mechanisms, but also is sufficiently accurate to enable the estimation of the order of magnitude of the effect for certain experimental conditions. This model suggests that this effect may find application in magnetoresistance and/or negative resistance devices and might prove useful in the measurement of surface parameters.

14406 MAGNETO-PLASMA RESONANCE IN SEMICONDUCTORS. I.

M.Date.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1488-92 (Aug., 1960).

The theory of the magneto-plasma resonance in semiconductors is developed for the general case where several kinds of free carriers are moving under a static magnetic field. Absorption and dispersion relations are obtained which are applicable to the usual semiconductors such as Si and Ge. It is shown that, under favourable conditions, the resultant plasma frequency can be determined as if there were only one kind of carrier which has the reduc of all the carriers concerned. The experimental method to de the parameter of the magneto-plasma resonance is also discu

14407 A NOTE ON DATE'S PAPER "MAGNETO-PLAS RESONANCE IN SEMICONDUCTORS. I".

K.Yamagata.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2363 (Dec., 1960).

Criticizes the treatment of Date (preceding abstract), wh be justified for spherical specimens and spherical energy su but not for silicon or germanium, where the energy surfaces highly anisotropic. It is shown that three different effective m conductivity or plasma, magneto-plasma and cyclotron mass, be introduced whose ratios depend on the anisotropy. J.

14408 RESONANCE TRANSFER OF IONIZATION ENER SEMICONDUCTORS.

S.Koshino and T.Ando.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1151-7 (June, 1961).

The thermal conductivity of a semiconductor due to the re ance transfer of ionization energy of the impurity state cause the interelectronic interaction is calculated in each of three te ature ranges, the extrinsic, the exhaustion and the intrinsic ra The conductivity increases exponentially with the temperature the extrinsic range, but decreases in the exhaustion range. In intrinsic range it increases again exponentially with the tempe when it is lower than a critical point, but decreases as the te ture increases beyond the critical point. The experimental de of the conductivity is possible under an appropriate condition intrinsic range, while impossible for almost all other cases.

14409 HOT ELECTRON BEHAVIOR AT HIGH PRESSURE.

L.Gold.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1269 (June, 1961).

The departure of the hot-electron characteristics in many valley semiconductors from Ohm's law, when under large hydrostatic pressure, is discussed. It is shown that the depar may be accounted for by the change in the energy gap produced the pressure. A

14410 RESONANCE TRANSFER OF IONIZATION ENERG SEMICONDUCTORS.

S.Koshino and T.Ando.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1538 (Aug., 1960).

The mechanism is considered whereby, when a free elect captured by a donor, its energy releases an electron from ano donor. If a temperature gradient exists in the sample, there i flow of ionization energy which contributes to the total therma current. A formula for this contribution is derived under sim assumptions holding for small donor concentrations.

L.Pin

14411 SYMMETRY PROPERTIES OF WARM ELECTRON EFFECTS IN CUBIC SEMICONDUCTORS.

K.J.Schmidt-Tiedemann.
Phys. Rev. (USA), Vol. 123, No. 6, 1999-2000 (Sept. 15, 1961).

The constant β which describes the field dependence of the mobility μ of warm electrons according to $\mu = \mu_0(1 + \beta E^2)$ is fo to be anisotropic even for crystals of cubic symmetry. Furthe the directions of field strength and current density include an the tangent of which is given by $E^2(\gamma_0/2)\sin\varphi\cos\varphi(1 - 3\cos^2\varphi)$ where φ is the angle between the field situated in the (110) pla and the cubic axis, and γ_0 is a constant. For silicon and germa one finds the following symmetry relations: $\beta_{110} = \beta_{100} - (\gamma_0/$ $\beta_{111} = \beta_{100} - (2\gamma_0/3)$, where the subscripts denote the direction field strength. The theoretical results were confirmed experi ally with n-type germanium of different impurity content.

14412 THE PHONON-ASSISTED AUGER EFFECT IN SEM CONDUCTORS.

D.M.Eagles.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 204-16 (Aug., 1961).

Some calculations on the effect of phonons on Auger recom nation and impact ionization in semiconductors with simple ba are presented. It is shown that phonon-assisted Auger recomb will dominate the direct Auger process at low temperatures, a that in highly doped specimens the recombination rate due to t phonon-assisted Auger effect can be comparable with rates generally expected from other mechanisms. At low carrier te tures the rate of phonon-assisted impact ionization will be gre than the direct impact ionization rate. However, phonon-assis impact ionization may be difficult to detect because of other co plications.

1413 INTERACTION OF ELECTRONS AND HOLES WITH ACOUSTIC WAVES IN INTRINSIC SEMICONDUCTORS.

koshiba.

ıys. Soc. Japan, Vol. 16, No. 5, 895-905 (May, 1961).

A self-consistent semiclassical theory is given for explaining haracteristics of the interaction of electrons and holes with stic waves in intrinsic semiconductors. The ultrasonic rption coefficient can be written as

$$\Lambda = \Lambda_R + \Lambda_K,$$

e Λ_R is due to the change of the deformation potential energies ectrons and holes caused by their recombination, and Λ_K is to the change of the kinetic energy caused by the intraband sition. The formula of Λ_R is identical with that used by hgate in the analysis of his experiments [Bull. Amer. Phys. Ser. II, Vol. 4, 462 (1959)] if the frequency at which $\omega\tau = 1$ sfies the inequality $(ql)^2<3(\tau_0/\tau)$, where ω, q are the angular uency and the wave number of acoustic waves, and l, τ_0, τ are nean free path, the intraband relaxation time and the lifetime lectrons or holes respectively. Under the condition that the uency $\omega = 1/\tau$ satisfies $(ql)^2>3(\tau_0/\tau)$, no absorption peak can xpected contrary to the simple phenomenological treatment; ecomes smaller than the value of Southgate's formula and is ured by Λ_K. As a whole, the characteristics of the interaction very similar to those in many-valley semiconductors. The istoelectromotive force is too small to be detectable in the riments.

.4414 THE POSSIBILITY OF NEGATIVE RESISTANCE EFFECTS IN SEMICONDUCTORS.

.Ridley and T.B.Watkins.

c. Phys. Soc. (GB), Vol. 78, Pt 2, 293-304 (Aug., 1961).

The possibility of obtaining negative resistance effects in a new in semiconductors is discussed. The principle of the method is eat carriers in a high mobility sub-band with an electric field hat they transfer when they have a high enough "temperature" higher energy low mobility sub-band. The conditions required negative resistance are discussed generally and more specific litions are obtained for some simple cases of spherical and soidal bands by solving the Boltzmann equation. It is shown most favourable case is when the sub-bands are sufficiently rated in energy for the emission of optical phonons to be the inant mechanism for energy relaxation in both sub-bands. -Si alloys and some III—V compounds may have suitable sub- structures in the conduction bands. The case of p-type xially strained silicon appears to be marginal in the region re the current is proportional to the square root of the electric . The electrical instability of a crystal with a differential tive resistance is briefly discussed and it is pointed out that e sort of "electrical domain" formation may establish itself inhibit the observation of negative resistance. Side effects h can influence the condition for negative resistance such as cimen heating, which is advantageous, and impact ionization, ch is deleterious, are also discussed.

14415 INFLUENCE OF INTERELECTRONIC COLLISION ON HALL-MOBILITY IN NON-POLAR SEMICONDUCTOR.

chiyama.

gr. theor. Phys. (Japan), Vol. 24, No. 2, 455-6 (Aug., 1960).

The temperature variation of mobility ratio in the range of urity scattering is evaluated for the limiting cases of strong relectronic interaction and zero interaction. It is concluded the effect of this interaction is very small. A.J.Fox

14416 CALCULATION OF THE SURFACE RECOMBINATION RATE AND THE BULK LIFETIME OF CARRIERS ER NONSYMMETRICAL BOUNDARY CONDITIONS.

.Lytovchenko.

ayin. fiz. Zh. (USSR), Vol. 4, No. 3, 376-83 (1959). In Ukrainian.

14417 THE TEMPERATURE DEPENDENCE OF THE HALL COEFFICIENT AT A CONSTANT CONCENTRATION OF RRENT CARRIERS.

R.M.Vinets'kyi and O.H.Miselyuk.

ayin.fiz. Zh. (USSR), Vol. 4, No. 5, 664-9 (1959). In Ukrainian.

It is shown that at a constant concentration of current carriers temperature dependence of the Hall coefficient is due to the sition from lattice scattering to impurity scattering as the perature is lowered. Comparison of the experimental results the theory enables one in some cases to find the concentration mean free length of current carriers and the full impurity concentration in the specimen. In the temperature range where lattice scattering prevails, the Hall coefficient varies with temperature more rapidly than is suggested by the theory which is based on the assumption that the carrier mean free length connected with the lattice scattering is independent of the energy.

14418 THE THEORY OF THE ELECTRICAL CONDUCTIVITY OF SEMICONDUCTORS IN A MAGNETIC FIELD. I.

V.L.Gurevich and Yu.A.Firsov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 198-213 (Jan., 1961). In Russian.

A quantum theory of the transverse conductivity of semiconductors in a strong magnetic field is developed, taking the inelastic scattering of the electrons into account. If the interaction between the electrons and the scatterers is treated in the Born approximation, a formula is obtained for the conductivity in terms of an integral of the retarded two-particle Green's function of the electron system in a magnetic field. This formula is studied for the case where the electrons obey Boltzmann statistics and where one may neglect the influence of their mutual Coulomb interaction on the conductivity. Both the classical and the quantum regions of magnetic fields and scattering both by acoustical and by optical phonons are considered. By comparing the results obtained through solving the transport equation with those from quantal calculations in the classical region, it is shown that in practically the whole of that region one can apply the transport equation, with a collision operator which is independent of the magnetic field. The dependence is determined of the transverse low-temperature resistivity, which is caused by the scattering by optical phonons, on the magnetic field. It turns out that it may be a step function with many steps. In the quantum region, equations are derived for the transverse conductivity in different limiting cases. Resonance oscillations in the conductivity are predicted which are periodic in 1/H and which are connected with the scattering by optical phonons. Maxima in the oscillations may occur when the limiting frequency of the optical phonons is a multiple of the Larmor frequency. In the classical region the oscillations are a small quantum correction to the conductivity, but they are relatively large in the quantum region. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 137-46 (July, 1961)].

14419 THE EFFECT OF AN ELECTRIC FIELD ON THE ELECTRON TEMPERATURE, ELECTRICAL CONDUCTIVITY AND THERMIONIC EMISSION OF SEMICONDUCTORS. I. ELEMENTAL SEMICONDUCTORS. THEORY.

I.M.Dykman and P.M.Tomchuk.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2228-39 (Sept., 1960). In Russian.

The kinetic equation was solved in order to find the electron distribution function in elemental semiconductors in electric fields. Interactions of electrons with acoustic phonons and impurity centres, as well as their mutual Coulomb interactions, were allowed for. Under certain conditions mutual electron interactions led to a Maxwellian distribution with an effective temperature T, different from the lattice temperature T_0. Conduction currents and T were calculated as a function of the applied electric field and properties of a semiconductor. Since T could be much greater than T_0, thermionic emission might be strongly affected. The solution of the kinetic equation was used also to find the electron distribution function and electron current in a plasma. See also following abstract. [English translation in: Soviet Physics — Solid State (USA), Vol. 2, No. 9, 1988-98 (March, 1961)]. A.Tybulewicz

14420 THE INFLUENCE OF ELECTRIC FIELD ON THE TEMPERATURE OF ELECTRONS, ON ELECTRICAL CONDUCTION, AND THERMOELECTRIC EMISSION IN SEMICONDUCTORS. II. THE STUDY OF PLASMA OSCILLATIONS AND SHORT-RANGE INTERACTIONS.

P.M.Tomchuk.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1019-30 (April, 1961). In Russian.

For Pt I see preceding abstract. In a semiconductor the electron concentration is considerably greater than in a plasma. Thus the temperature of the electrons in a semiconductor is lower than in a plasma. The distribution function for an electron gas in an electric field is found from the kinetic equation. Both short-range and long-range interactions between electrons, and between electrons and the plasma oscillations are calculated. The influence of the plasma oscillations on electrical conductivity is also considered. The methods of Chapman and Cowling, and of Landau are compared, and the limitations in applying the latter method are discussed. See also following abstract. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 740-9 (Oct., 1961)]. D.J.Barber

14421 THE EFFECT OF ELECTRIC FIELD ON THE ELECTRON TEMPERATURE, ELECTRICAL CONDUCTIVITY AND THE THERMIONIC EMISSION OF ELECTRONS IN SEMICONDUCTORS. III. THERMIONIC EMISSION.
I.M.Dўkman and P.M.Tomchuk.

For Pt II see preceding abstract. The electron distribution function in a semiconductor in the presence of an electric field is derived, considering spherical symmetry. Criteria are established for the heating of electron gas by the field and the thermionic current I is calculated, condidering two cases; I independent of and dependant on, the mechanism of ionization by collision. In the first case the distribution function is approximately Maxwellian with electron temperatures equal to the temperature of the crystal lattice T_0. In the second case the distribution differs generally from Maxwellian, but under certain condition it may be approximately Maxwellian with the electron temperature between T_0 and T, where T is the temperature of electron gas. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 464-70 (Aug., 1961)]. J.M.Zarzycki

14422 FIELD-ENHANCED DONOR DIFFUSION IN DEGENERATE SEMICONDUCTOR LAYERS. W.Shockley.
J. appl. Phys. (USA), Vol. 32, No. 7, 1402-3 (July, 1961).

An effective diffusion constant was previously evaluated, allowing for the apparent increase in diffusion rate of donors or acceptors owing to the electric field that distributes the current carriers in non-degenerate semiconductors so that they neutralize the impurities. An expression is now given for the effect in degenerate semiconductors. C.A.Hogarth

14423 MONOTONIC TRAP DISTRIBUTIONS.
R.H.Bube.
J. appl. Phys. (USA), Vol. 32, No. 8, 1621 (Aug., 1961).

It was found that such distributions occur in semiconducting materials which have a highly defective crystal structure.
A.J.Fox

14424 BREAKDOWN IN NON-POLAR SEMICONDUCTORS.
Kh.Frelikh [H.Fröhlich].
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 670 (Feb., 1961).
In Russian.

Above a certain energy the mean free path of the electron increases with energy and if this is taken into account, the formula for breakdown obtained by Gordeev (Abstr. 15912 of 1960) becomes that derived by Fröhlich (Abstr. 2144 of 1956). [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 491 (Aug., 1961)].
Z.Krasucki

14425 THE DETERMINATION OF CERTAIN PARAMETERS OF A SEMICONDUCTOR FROM THE SLOPE OF THE SPECTRAL RESPONSE OF THE PHOTOCONDUCTIVITY.
V.A.Petrusevich.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1268-71 (April, 1961).
In Russian.

A theoretical treatment is developed for the determination of recombination constants and large absorption coefficients of semiconductors without measurements on very thin specimens. This is possible in principle by the observation of the photoconductivity response spectrum and knowledge of the diffusion length for the specimen. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 920-2 (Oct., 1961)]. K.N.R.Taylor

14426 THE DETERMINATION OF THE CHARACTERISTIC PARAMETERS OF MINORITY CARRIERS IN SEMICONDUCTORS FROM THE MEASUREMENT OF THE PHOTOCONDUCTIVITY AND PHOTOMAGNETIC EFFECT. Yu.I.Ravich.
Fiz. tverdovo Tela (USSR), Vol. 3, No. 5, 1601-11 (May, 1961).
In Russian.

The photoconductivity and photomagnetic effect are calculated in the presence of trapping levels, for the case of non-linear recombination and for a specimen of cylindrical shape. The determination of the recombination constants and the mobility of the minority carriers from the measurements of these effects is examined. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Huntley

14427 ON THE STUDY OF VOLUME RECOMBINATION O EXCESS CHARGE CARRIERS IN SEMICONDUCTO WITH THE AID OF PHOTOCONDUCTANCE. B.H.Schultz.
Philips Res. Rep. (Netherlands), Vol. 16, No. 2, 175-81 (April, 196

A method is described for the elimination of surface effec measurements of volume-recombination lifetimes with the aid photoconductance. The measurements indicate directly whethe or not it is possible to deduce a reliable value for the volume-recombination lifetime..

Semiconducting Materials

14428 CONFERENCE ON SEMICONDUCTING COMPOUNI
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2063-2304 (Oct., 1961).

The conference was held in New York on June 14-16, 1961 the sponsorship of the Air Force Office of Scientific Research, Office of Aerospace Research, USAF and the General Electric Research Laboratory. The aim of the conference was to summari both experimental and theoretical results in various classes of compounds, and if possible, to synthesize physical ideas comm these compounds. Emphasis was therefore placed on the 3-5 an 2-6 compounds with some discussion of the lead compounds anc oxides. The conference was restricted to fundamental physical properties, such as band structure, transport, optical, galvanomagnetic and resonance phenomena. Abstracts of the papers presented will be found in this or succeeding issues of Physics Abstracts.

14429 THE USE OF HIGH-PRESSURE FURNACES IN THE PREPARATION OF INTERMETALLIC SEMICONDU
L.Giraudier.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 149A-154A (N 1960). In French.

Describes the main features, improvements and directions use of a high-pressure furnace in which have been prepared, wi fair reproducibility and purity, compounds of magnesium with group IV elements.

14430 SLOW NON-EXPONENTIAL CHANGES OF SURFAC CONDUCTIVITY OF GERMANIUM. S.Koc.
Czech. J. Phys., Vol. 11, No. 3, 193-8 (1961).

A study was made of slow relaxation effects produced durin changes in the external d.c. electric field above the oxided surfa of germanium and an empirical relation was found to describe t time dependence. It is seen that the activation energy of the cor process, which is about 0.4 eV, can be determined from the tem ture dependence of slow effects.

14431 INFLUENCE OF RELATIVE HUMIDITY ON SURFA CONDUCTIVITY OF GERMANIUM. G.Dorda.
Czech. J. Phys., Vol. 10, No. 11, 820-9 (1960).

A study was made of the influence of the relative humidity (from 0.5 to 90%) on the surface conductivity of both p- and n-ty germanium having differing resistivity. It was found that the ra of changes in the surface potential did not depend on the volume properties of germanium. An analysis of the experimental resu shows that the surface potential has values approximately in the range from $\varphi_s = -3kT/q$ to $\varphi_s = +5kT/q$ for a change in humidi from 0.5 to 90%. Assuming that the Fermi level changes on the side of the oxide layer by approximately the same value as on th germanium—germanium oxide boundary as a result of the increa and decrease of slow states, it follows that the levels of the slow centres are considerably distant from the Fermi level during th whole humidity range. It is also shown that on the first monomo cular layer of adsorbed water there is an increment of (7.5 ± 0.8) × donor levels per cm^2. This increase in levels either decreases with the number of adsorbed monomolecular layers of water and 90% humidity has approximately the value 2×10^{10} cm^{-2} or rema almost unchanged with the number of layers, if it is assumed tha for $\varphi_s = 6.0kT/q$ the Fermi level passes through the centres of sorbed water.

14432 THERMAL EFFECTS IN STUDIES OF THE ELECTRICAL CONDUCTIVITY OF GERMANIUM AT LIQUID-HELIUM TEMPERATURES. É.I.Zavaritskaya.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3009-11 (Dec., 1960)
In Russian.

Reports discontinuous rise of current and temperature in nanium samples, alloyed with group III and V elements, on ease of applied voltage above the "low-temperature breakdown" e at helium temperatures (1.7°K and above). [English slation in: Soviet Physics - Solid State (USA), Vol. 2, No. 12, -5 (June, 1961)]. A.Tybulewicz

14433 AN INVESTIGATION OF THE PROPERTIES OF GERMANIUM SURFACES AT VARIOUS TEMPERATURES. MPLITUDE CHARACTERISTICS.

.Litovchenko and V.I.Lyashenko.
. tverdogo Tela (USSR), Vol. 3, No. 1, 61-72 (Jan., 1961).
ussian.

Studied at 170-305°K. The results confirmed the discrete ribution of surface levels in the forbidden band. The tempera- dependences of parameters of "fast" and "slow" surface states e determined, as well as the surface potential and the work tion. [English translation in: Soviet Physics—Solid State (USA), . 3, No. 1, 44-52 (July, 1961)]. A.Tybulewicz

14434 AN INVESTIGATION OF THE PROPERTIES OF GERMANIUM SURFACES AT VARIOUS TEMPERATURES. KINETICS OF SURFACE PROCESSES.

.Litovchenko and V.I.Lyashenko.
. tverdogo Tela (USSR), Vol. 3, No. 1, 73-88 (Jan., 1961).
ussian.

Reports a study of the field effect and photoconductivity at 170- °K, and compares the kinetics of the two effects. The tempera- dependence of the capture cross-sections and of other para- ers of the surface electron states is reported. [English trans- on in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 53-64 y, 1961)]. A.Tybulewicz

14435 INVESTIGATION OF COARSE-GRAINED GERMANIUM LAYERS PRODUCED BY PYROLYSIS OF GAS.

.Kurov, N.N.Sheftal' and N.P.Kokorish.
, tverdogo Tela (USSR), Vol. 3, No. 2, 370-2 (Feb., 1961).
ussian.

Reports a study of some electrical properties of 10-50μ thick manium layers prepared by pyrolysis; the layers had resistivit- of 25-35 ohm/cm. The conduction type depended on dimensions rystal grains in pure layers. On alloying with impurities the ers exhibited pronounced conductivity of n- or p-type. It is con- led that properties of coarse-grained layers are governed by urities in the same way as properties of large monocrystals. glish translation in: Soviet Physics - Solid State (USA), Vol. 3, 2, 269-70 (Aug., 1961)].

14436 INVESTIGATION OF THE [FAST] SURFACE STATES OF GERMANIUM.

.Lyashenko, V.G.Lytovchenko and I.H.Sambur.
ayin. fiz. Zh. (USSR), Vol. 4, No. 4, 465-71 (1959). In Ukrainian.

Investigated by the pulse method. Data on the energy distri- ion and concentration are presented. The d.c. internal electrical d ($\gtrsim \pm 10^5$ V/cm) was found to cause a rise in the concentration states I and II (i.e. it is a function of the sign of the internal d). The adsorption of dry air molecules leads to a rise in the centration of I-states (after several days). Some inferences drawn as to the nature of fast surface states.

14437 THE NATURE OF THE SURFACE RECOMBINATION CENTRES IN GERMANIUM.

.Rzhanov, Yu.F.Novototskii-Vlasov, I.G.Neizvestnȳi, .Pokrovskaya and T.I.Galkina.
. tverdogo Tela (USSR), Vol. 3, No. 3, 822-31 (March, 1961).
ussian.

The method described previously (Abstr. 2874 of 1960) was used neasure simultaneously the stationary photoconductivity and the d-effect for large signals. This gives the dependence of the rate urface recombination and the charge trapped at the surface, on electrostatic potential of the surface. Measurements were made 00°K and 10^{-6} mm Hg after heating. It is suggested that the in- ase in recombination centres on heating up to 500°K is due to the noval of water from the oxide layer; the activation energy for this 4 kcal/mole. On heating above this temperature, the number reases, possibly due to the desorption of O atoms or a change in ding. If all centres have the same cross-section, this is 10^{-14} cm^2 for holes and $\sim 10^{-15}$ cm^2 for electrons. [English nslation in: Soviet Physics - Solid State (USA), Vol. 3, No. 3, -6 (Sept., 1961)]. R.Berman

14438 THE TEMPERATURE DEPENDENCE OF THE PARAMETERS OF THE SURFACE RECOMBINATION CENTRES IN GERMANIUM.

A.V.Rzhanov, N.M.Pavlov and M.A.Selezneva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 832-40 (March, 1961).
In Russian.

The temperature dependence of the surface recombination rate between 250° and 328°K was measured before and after heating in vacuum to 150°C. The results indicate that there is no temperature dependence of the recombination energy levels but a dependence of the capture cross-section. The latter is shown in a figure; the greatest change occurs at low temperatures and the investigations will be continued to lower temperatures. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 3, 607-12 (Sept., 1961)]. R.Berman

14439 AN EXPERIMENTAL STUDY OF THE VOLUME GRADIENT E.M.F. APPEARING IN GERMANIUM IN THE PRESENCE OF A CURRENT.

P.I.Baranskii, G.M.Dzyubenko and N.S.Konoplyasova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 876-83 (March, 1961).
In Russian. For abstract, see Abstr. 12435 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 638-42 (Sept., 1961)].

14440 EFFECT OF GASEOUS AMBIENTS UPON 1/f NOISE IN GERMANIUM FILAMENTS.

V.E.Noble and J.E.Thomas, Jr.
J. appl. Phys. (USA), Vol. 32, No. 9, 1709-14 (Sept., 1961).

The variation of 1/f noise in thin, single crystal germanium filaments was investigated by using gaseous ambients to change the surface potential of the sample. The noise samples, having a thickness of only 4μ, were extremely sensitive to variations in the surface potential and exhibited large fractional changes of the total sample conductance as a result of the surface conductance fluctuations which were interpreted as the 1/f noise. These experimental results showed a definite noise minimum when the sample surface potential correspond to the sample conductance minimum. The r.m.s. conductance fluctuations varied roughly linearly with ΔG, where ΔG is the increase of the sample conductance with respect to the minimum value. The slope of the curve for the condition of an accumulation layer on the sample surface was an order of magnitude less than that for the inversion layer. The amplitude of the accumulation noise agreed (within a factor of two) with the prediction of McWhorter's majority carrier trapping effect, but the inversion noise was an order of magnitude greater.

14441 PROPERTIES OF HEAVILY DOPED N-TYPE GERMANIUM.

W.G.Spitzer, F.A.Trumbore and R.A.Logan.
J. appl. Phys. (USA), Vol. 32, No. 10, 1822-30 (Oct., 1961).

The electrical and optical properties of n-type germanium were studied for doping levels greater than 5×10^{18} cm^{-3}. Hall coefficient and resistivity measurements show that the electron mobility μ depends upon the specific group V donor used as a dopant and, at a given carrier concentration, increases in the order $\mu_{As} < \mu_P < \mu_{Sb}$. In material doped very heavily with arsenic, a large fraction of the arsenic was found to be electrically inactive. Rapid quenching of this material resulted in larger carrier concentrations and a better correlation with crystal growth parameters. Distribution coefficients were calculated from the electrical measurements on antimony-doped crystals grown by a solvent evaporation technique. No significant "facet effect" was observed for these crystals. Reflectivity measurements between 2 and 24 μ were used to deduce the electron effective mass as a function of carrier concentration. In the carrier concentration range studied (up to 8×10^{19} cm^{-3}), the effective mass only increases slightly and is independent of the specific dopant. The free carrier absorption is dependent on dopant. The absorption and electrical data are correlated by elementary conduction theory.

14442 EFFECT OF REACTOR FAST NEUTRONS ON ELECTRON-HOLE RECOMBINATION IN GERMANIUM.

A.Czachor and J.Piekoszewski.
J. appl. Phys. (USA), Vol. 32, No. 10, 1837-40 (Oct., 1961).

The properties of recombination centres introduced by reactor fast neutrons in n-type germanium were investigated. From the temperature dependence of carrier lifetime, using Shockley—Read statistics, the recombination-level position was calculated and found to depend on the resistivity of the germanium. It was observed for the first time that in the low temperature region the lifetime increases with decreasing temperature.

14443 THE MEAN ENERGY OF GENERATION OF NON-EQUILIBRIUM CARRIER PAIRS BY EXPOSURE OF GERMANIUM TO γ-RAYS FROM COBALT-60.

M.V.Chukichev and V.S.Vavilov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 935-42 (March, 1961). In Russian.

Observations of the photo-e.m.f. in germanium, arising from exposure to γ-rays, were used to obtain a value for the mean energy expended by a γ-ray in producing an electron-hole pair. This energy was found to be 2.5 ± 0.3 eV, in agreement with published results on the quantum yield of photoionization in the ultraviolet and soft X-ray region of the spectrum. The results confirm that the mean energy is not dependent on the energy of the absorbed quantum. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 3, 680-4 (Sept., 1961)]. K.N.R.Taylor

14444 HOT ELECTRON NONEQUILIBRIUM CARRIER DISTRIBUTION IN A MANY VALLEY SEMICONDUCTOR.

L.Gold.

J. Phys. Soc. Japan, Vol. 16, No. 3, 575 (March, 1961).

The contribution of non-uniform charge density of the ellipsoidal energy surfaces in Ge was studied on the basis of a hot electron formalism previously described (Abstr. 3258 of 1957) and found to lead to a non-collinear current—voltage relation. D.J.Huntley

14445 ELECTRICAL PROPERTIES OF HEAVILY DOPED N-TYPE GERMANIUM.

Y.Furukawa.

J. Phys. Soc. Japan, Vol. 16, No. 4, 687-94 (April, 1961).

Experimental studies were made on electrical resistivity, Hall coefficient and magnetoresistance of As- Sb- and (As + Sb)-doped Ge in the electron concentration range of ($10^{18} \sim 3 \times 10^{19}$ cm^{-3}). The mobility difference between As- and Sb-doped Ge was observed at room temperature. This difference seems to be related with the difference in the ionization energy of group V elements. From the present experiment, it was concluded that in heavily doped Ge, interaction between electrons and ionized impurities should be treated as a short range force instead of a Coulomb force owing to the fairly large screening effect, and as a result the nature of the core of impurity directly influences the impurity scattering.

14446 DONOR EQUILIBRIA IN THE GERMANIUM—OXYGEN SYSTEM.

C.S.Fuller, W.Kaiser and C.D.Thurmond.

J. Phys. Chem. Solids (GB), Vol. 16. No. 1-2, 161-3 (Nov., 1960).

The assumption that GeO_4 is completely ionized as a single donor is supported and the reactions involving oxygen that lead to the formation of donors in Ge approximate to the classical laws of mass action. The agreement between donor and oxygen concentration suggests a method of determining the oxygen concentration in Ge. G.C.Williams

14447 RECOMBINATION AT COPPER AND AT NICKEL CENTRES IN P-TYPE GERMANIUM.

B.H.Schultz.

Philips Res. Rep. (Netherlands), Vol. 16, No. 2, 182-6 (April, 1961).

Recombination rates at copper centres show a different temperature dependence for partly compensated and non-compensated crystals. This can be attributed to the additional recombination at neutral copper atoms, assuming $\sigma_n \cong 10^{-16}$ cm^2. In this way the contradiction in the existing literature is solved. For the recombination at nickel centres the existing discrepancies could not be solved. Measurements are reported, and the results are in agreement with those of Wertheim (Abstr. 12262 of 1959).

14448 INTERBAND SCATTERING IN N-TYPE GERMANIUM.

M.I.Nathan, W.Paul and H.Brooks.

Phys. Rev. (USA), Vol. 124, No. 2, 391-407 (Oct. 15, 1961).

The pressure dependence of the electrical conductivity of n-type germanium was measured to pressures of 30 000 kg/cm^2 at temperatures between 273° and 350°K. A satisfactory explanation of the results requires the existence of two different types of minima in the conduction band, separated by between 0.15 and 0.21 eV at 350°K with the lower range of values slightly preferred. The higher energy minima lie in the [100] direction in reciprocal space, and are similar in properties to the lowest set of minima in silicon. The changes in position of the two minima with pressure are determined. For the minima that are lowest at atmospheric pressure,

$$d(E_{111} - E_V)/dP = (4.9 \pm 0.5) \times 10^{-6} \text{ eV/kg cm}^{-2},$$

and for the [100] set,

$$d(E_{100} - E_V)/dP = (0_{-2}^{+1}) \times 10^{-6} \text{ eV/kg cm}^{-2}.$$

The change in average electron mobility with pressure is expl in terms of a sharing of electrons between states in the two se minima, and an additional relaxation process that scatters car from one type of minimum into the other. The effect of pressu on the effective masses, the elastic constants, and the deforma potential is briefly considered.

14449 THE MEASUREMENT OF THE HALL EFFECT W THE AID OF MICROWAVES IN GERMANIUM SPECIMENS CHANGING FROM N-TYPE TO P-TYPE WITH CHANGING TEMPERATURE.

T.Stubb.

State Inst. Tech. Res. Publ. (Finland), No. 60, 19 pp. (1961).

The crystal (1 mm thick) forms the common wall of two rectangular waveguides with perpendicular axes. The sample high vacuo and can be cooled to 100°K by liquid air. Fitting o contacts and etching is described. The microwave bridge is inserted in a modification of Hambleton and Gärtner's circuit [Amer. Phys. Soc., p. 259 (1959)]. Graphs show the resistivity two crystals in the temperature range 100-300°K and detector voltage as a function of temperature in this range with d.c. fiel of 3-7 kG. Absorption is revealed by a drop in voltage (and in resistivity) at 250°K. D.E.

14450 INFLUENCE OF ILLUMINATION ON THE FIELD EFFECT.

N.S.Chorna.

Ukrayin.fiz. Zh. (USSR), Vol. 3, No. 3, 424-7 (1958). In Ukrain

Describes measurements made on 15-17 ohm cm, n-type vacuo (10^{-5} mm Hg) and in CO (7mm Hg).

14451 EFFECT OF AN [EXTERNAL] ELECTRIC FIELD THE HALL EFFECT [AND CONDUCTIVITY] IN Ge AT VARIOUS TEMPERATURES.

T.N.Sӯtenko.

Ukrayin.fiz. Zh. (USSR), Vol. 3, No. 4, 475-81 (1958). In Ukrai

Studied from −60°C to room temperature using 30 ohm cn p—Ge. It is shown that the conductivity curves $\Delta\sigma = f(E_V)$ and Hall effect $\Delta R_x = f(E_V)$ at various temperatures pass through extremes with unequal values of the external electric field. Th latter is evidently connected with the dependence of the bending the surface bands on the specimen temperature.

14452 SIGN OF THE CONDUCTIVITY OF POWDERED Ge FILMS.

Yu.H.Ptushӯns'kӯi and Yu.A.Lupan.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 125 (1959). In Ukraini

14453 PROPERTIES OF GERMANIUM WITH A BERYLLI ADDITION.

V.Ye.Lashkar'ov, R.M.Bondarenko, V.M.Dobrovol'skӯi, H.P.Z V.G.Lӯtovchenko and V.I.Strikha.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 372-5 (1959). In Ukrai

The electrical and recombination properties were investig Beryllium proves to be an acceptor with a solubility limit of th order of 10^{19} cm^{-3}. Investigations of the dependence of the Hal carrier mobility on the concentration and a comparison with a ous dependences for zinc and gallium showed that beryllium is doubly ionized. The energy of ionization was found to be high, equalling 0.07 ± 0.005 eV. Recombination at room temperatur on at levels which are 0.17 ± 0.01 eV higher than the upper bo ary of the valency band.

ELECTRIC-FIELD-INDUCED MODULATION OF THE ABSORPTION DUE TO INTERBAND TRANSITIONS OF FREE HOLES IN GERMANIUM. See Abstr. 14580

14454 EXPERIMENTS ON THE VARIATION OF SURFAC CONDUCTIVITY IN GERMANIUM AND SILICON.

M.L.Ioselevich and V.I.Fistul'.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1132-6 (April, 1961). In Russian.

Measurements of the surface conductivity of crystalline G Si, covered with both oxidizing and reducing layers, were mad A correlation was found between the ionization potential of the adsorbed ions and the change in conductivity. For potentials l than a critical value, there is an increase in the conductivity; for potentials greater than this value there is a decrease. Thi critical potential is in the range 7.8-9.0 eV, which contains the ionization potential of germanium. Current—voltage curves, u a point contact on n-type silicon with various surface treatmen are shown. [English translation in: Soviet Physics—Solid Stat Vol. 3, No. 4, 822-5 (Oct., 1961)]. K.N.R.

14455 ENERGY STRUCTURE OF COMPLEX SEMICONDUCTORS. CALCULATION OF THE BAND .UCTURE OF Si, Ge AND GaAs BY A SIMPLIFIED ORTHOG- ıLIZED PLANE WAVE METHOD.
[.Gashimzade and V.E.Khartsiev.
. tverdogo Tela (USSR), Vol. 3, No. 5, 1453-7 (May, 1961).
:ussian.

The energy band structures of Si, Ge and GaAs were calculated g the method of orthogonalized plane waves with the effective ılsive potential assumed by Antončik (Abstr. 867 of 1959). er's functions were used as wave-functions in the calculations. results obtained for Si and Ge are in surprisingly good agree- ıt with those of other authors. It is suggested that this method ıld be applied to complex semiconducting compounds. [English ıslation in: Soviet Physics—Solid State (USA)]. N.Davy

ı4456 DISTRIBUTION COEFFICIENT OF ANTIMONY IN SILICON FROM SOLVENT EVAPORATION ᴾERIMENTS. F.A.Trumbore, P.E.Freeland and R.A.Logan.
:lectrochem. Soc. (USA), Vol. 108, No. 5, 458-60 (May, 1961).

Distribution coefficients were calculated from Hall-effect ısurements on heavily doped silicon crystals grown by a solvent ɔoration technique from melts containing between 2 and 8 at.% mony. Nearly a twofold decrease in the distribution coefficient m 0.02 to 0.01) was observed in this concentration range. It ɜars that any "facet effect," if present, was small and that near- .librium solid solubilities were obtained.

4457 α-TRAPPING CENTERS IN n—TYPE SILICON.
J.Okada and T.Suzuki.
'hys. Soc. Japan, Vol. 15, No. 9, 1709 (Sept., 1960).

The density of α-trapping centres is claimed to pass through aximum after approximately 30 min annealing at 450°C instead ıcreasing monotonically with annealing time as was expected. · therefore assumed that α-trapping centres are not due ·ctly to two or three oxygen atom complexes, as has been suggest- ɪreviously, but arise when these complexes interact with other urities and/or lattice imperfections. F.A.Baker

4458 ANNEALING OF RADIATION DAMAGE ON LIFETIME IN SILICON. K.Matsuura and Y.Inuishi.
'hys. Soc. Japan, Vol. 16, No. 2, 339 (Feb., 1961).

The values of $1/\tau - 1/\tau_0$ with isochronal and isothermal annealing rradiated Czochralski n-type single crystals have a maximum bout 200°C, where τ_0 and τ are the lifetimes measured at room perature before irradation and after each annealing. No ːimum is observed for float-zoned specimens, where the calculat- .ctivation energy of annealing is 1.2 eV. Experiments to clarify the .hanism of interaction between defects induced by radiation oxygen are in progress. G.C.Williams

4459 IMPURITY EFFECT UPON MOBILITY IN HEAVILY DOPED SILICON. Y.Furukawa.
hys. Soc. Japan, Vol. 16, No. 3, 577 (March, 1961).

Experimental results indicate that the lower the ionization :gy of the group III and group V impurities the higher the Hall ilities in Si. A similar trend was observed in Ge.

G.C.Williams

14460 TRANSIENT CHARGE-CARRIER DIFFUSION IN HIGH-PURITY SILICON. M.Green and I.N.Greenberg.
d-State Electronics (GB), Vol. 1, No. 1, 85-92 (March, 1960).

Presents the results of an experimental and theoretical study he transient current resulting from the diffusion of a pulse of rge carriers photoinjected into high-resistivity silicon (~1900 ı cm p-type and 590 ohm cm n-type). The charges diffused to were detected as a photovoltaic current by the metal-to-silicon :act which, in all cases, was found to be rectifying at room perature. Experimentally, it was found that the initial slope of curve of α^2(α is the distance from the point of injection to the :tion) versus the time of occurrence of the maximum in the diffu- ı current averages about 6D for electrons in p-type silicon and · for holes in n-type silicon (D is the appropriate diffusion con- ıt). The theory developed predicts a slope of 6D for both elect- s and holes. Discrepancies are attributed to (a) effect of light ttered from source to junction, (b) inaccuracies in the measure- ıt of α and (c) errors in extrapolating to zero total resistance. › peak photocurrents are distinguished: one due to diffusion of riers to the junction, and one due to carriers generated at the :tion by scattered light; as a consequence of the total circuit istance, the first of these decreases more slowly than the second. The phenomenon is explained on the basis of a variational analysis of the total current-density equation. An effective sample lifetime and an effective junction electric field for each external resistance were determined from the experimental data and the theoretical equations. Values of lifetime obtained in this way are 15-20 μsec for the p-type specimen and 30-40 μsec for the n-type (values on these same specimens obtained by the decay of the photoconductivity are larger by a factor of 2). The junction electric field values obtained when the total circuit resistances are extrapolated to zero range from tenths to several V/cm.

EFFECT OF CONDUCTION TYPE ON PHOTOELECTRIC EMISSION OF SILICON. See Abstr. 13113

14461 RECENT WORK ON SURFACE PROPERTIES OF II—VI SEMICONDUCTORS. J.J.Lander.
J. Phys. Chem. Solids (GB), Vol. 14, 137-41 (July, 1960).

Recent work on the surface chemistry of single crystals of ZnO and on the surface conductivity and photoconductivity of ZnO, CdS and CdSe is discussed in outline. The bulk electrical properties of sintered II—VI compounds are often due to surface and intergranular effects, even above room temperature, and the use of these compounds as electroluminescent materials is briefly mentioned. R.Parker

14462 THE PREPARATION AND PROPERTIES OF SOME II-V SEMICONDUCTING COMPOUNDS.
G.A.Silvey, V.J.Lyons and V.J.Silvestri.
J. Electrochem. Soc. (USA), Vol. 108, No. 7, 653-8 (July, 1961).

The methods of purification and single crystal growth of six II-V semiconducting compounds are discussed and crystallographic data are presented. The six compounds, representing three stoichiometries, are Cd_3As_2, $CdAs_2$, CdSb, Zn_3As_2, $ZnAs_2$, and ZnSb. The compounds are thermally dissociated in the vapour phase, and the solid-vapour equilibria of four of the compounds was measured. Because of the thermal instability, crystal pulling was carried out in sealed quartz tubes employing magnetic suspension of the seed. Through purification of the elements and single crystal growth, high purity was attained in most of the compounds. The highest purity is represented in $CdAs_2$ with an electron carrier concentration of 5×10^{14} cm^{-3}.

14463 INVESTIGATION OF A THERMALLY-EXCITED CURRENT IN CdS MONOCRYSTALS.
A.P.Trofimenko and H.A.Fedorus.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 468-74 (1958). In Ukrainian.

Deals with the effect of the thermal excitation of current in the temperature range from −210° to +150° C. It is shown that the curves of a thermally-excited current for unannealed specimens have several (from 2 to 6) maxima; the value and position of these may vary for different crystals. The respective curves for specimens subjected to preliminary annealing in vacuo and in an atmosphere of argon and hydrogen are distinguished by having only one relatively narrow maximum within the temperature range −195° to −170° C. Monocrystals annealed in cadmium vapour, or subjected to tempering after annealing, also reveal the presence of only a single maximum at low temperatures, but the thermal current excitation curve descends at a much lower rate on raising the temperature. A number of maxima in a wide temperature range were noted for specimens annealed in sulphur vapour. Two maxima are particularly characteristic at temperatures of −2° and +32° C. A study of CdS monocrystals with a metal admixture showed that, along with the first low-temperature maximum, there appears a second maximum at a higher temperature. The results obtained permit the approximate determination of the position of certain local levels in the forbidden band of CdS.

14464 ELECTRICAL PROPERTIES OF THE CdTe—HgTe SYSTEM. R.Gałązka and W.Giriat.
Bull. Acad. Polon. Sci. Ser. Sci. math.astron. phys. (Poland) Vol. 9, No. 4, 281-5 (1961).

From measurements of electrical conductivity σ and Hall coefficient R of specimens with a HgTe molar composition varying from 50 to 90%, σR was determined as a function of T from 190° to 540° K. Assuming the semiconductor is homogeneous and isotropic and the predominant scattering is due to phonons in the acoustic range, the forbidden energy ΔE is found to be between 0.25 eV and 1.0 eV. The variation in ΔE is considered to arise from deviations from stoichiometry and theory. G.C.Williams

14465

ELECTRICAL AND MAGNETIC PROPERTIES OF CHROMIUM SULPHIDES. T.Kamigaichi.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 371-88 (Oct., 1960).

The electrical conductivity σ, thermoelectric power α, and magnetic susceptibility χ of CrS_x with $0.95 \leq x \leq 1.20$ were measured from 77 to 800°K. For $0.95 \leq x \leq 1.12$ the specimens are semiconductors at room temperature but an anomaly in σ and α at 350°C indicates a transition from $CrS + Cr_7S_8$ (of NiAs structure) to the pure NiAs structure. For $1.13 \leq x \leq 1.20$ the specimens are metallic with negative α. CrS and NiAs-type Cr_7S_8 are antiferromagnetic substances with Néel temperatures of 180 and −140°C respectively. For $x \cong 1.17$ the specimens are ferrimagnetic.

C.A.Hogarth

14466

BEHAVIOUR OF MAGNESIUM IMPURITY IN GALLIUM ARSENIDE. J.R.Knight.

Nature (GB), Vol. 190, 999-1000 (June 10, 1961).

The anomalous electrical behaviour in GaAs, previously attributed to Mg (an acceptor), may be explained by the introduction of Si (a donor) into the melt as a result of reaction between Mg and the inner surface of the silica tube used for the experiments. The ratio of Si/Mg in the melt is determined by the composition of the oxide phase in equilibrium with the melt. G.C.Williams

14467

AN IMPURITY BAND IN P- AND N-TYPE CRYSTALS OF GALLIUM ARSENIDE.

O.V.Emel'yanenko, T.S.Lagunova and D.N.Nasledov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 198-203 (Jan., 1961).
In Russian.

The electrical conductivity and the Hall constant were measured on monocrystals at 2-600°K. In strongly doped samples, the Hall constant was independent of temperature and the conductivity was not greatly affected by cooling. In p-type samples with carrier densities $p \lesssim 4 \times 10^{16}$ cm^{-3}, a Hall-constant maximum was observed at low temperatures and the conductivity fell strongly on cooling. An n-type sample with a carrier density of 2×10^{16} cm^{-3} behaved in the same way. An anomalous fall of the magnetoresistance of n-type samples was observed at low temperatures. The results are interpreted in terms of conduction processes in an impurity band. [English translation in: Soviet Physics—Solid State (USA) Vol. 3, No. 1, 144-7 (July, 1961)]. A.Tybulewicz

14468

INFLUENCE OF THE HALL EFFECT UPON THE TRANSVERSE MAGNETORESISTANCE IN INDIUM ANTIMONIDE. C.A.Simmons.

J. appl. Phys. (USA), Vol. 32, No. 10, 1970-4 (Oct., 1961).

A detailed experimental investigation of the influence of the specimen geometry on the transverse magnetoresistance was made. The bulk properties and the geometrical contributions were differentiated. It was found that the enhancement of the magnetoresistance effect in rectangular elements is due to the Hall effect, rather than to its absence, and that the bulk property has an H^2 relationship while the geometry effect is linear with H and inversely proportional to the length-to-width ratio.

14469

TRANSPORT OF CURRENT CARRIERS IN N-TYPE INDIUM ANTIMONIDE AT LOW TEMPERATURES.

J.Kołodziejczak.

Acta phys. Polon. (Poland), Vol. 20, No. 4, 289-302 (1961).

The conductivity, Hall effect, and electron mobility are computed within the temperature range from 0° to 100°K, account being taken of the non-parabolic structure of the conduction band, the ionic mechanism of scattering, and a weak magnetic field. The dependence of the effective mass on the electron concentration is derived. The transport equation is solved by McClure's general method (Abstr. 3718 of 1956).

14470

THE EFFECT OF ANNEALING ON THE ELECTRIC AND GALVANOMAGNETIC PROPERTIES OF INDIUM ANTIMONIDE. V.E.Il'in and I.E.Gorbacheva.

Fiz.tverdogo Tela (USSR), Vol. 3, No. 2, 534-44 (Feb., 1961).
In Russian.

Using n- and p-type specimens, the effects of annealing at various temperatures on the following quantities were measured: (1) the Hall constant R, and its relation to temperature; (2) the electrical conductivity σ and its relation to temperature; (3) the relations connecting R, σ, and the fractional change of resistance $\Delta\rho_H/\rho_0$ with H, the magnetic field; (4) the effect of H on R, σ and $\Delta\rho_H/\rho_0$ regarded as functions of 1/T, where T is the temperature. Results are exhibited graphically and discussed at some lengt [English translation in: Soviet Physics—Solid State (USA), Vo No. 2, 392-9 (Aug., 1961)].

14471

INTERPRETATION OF THE ANISOTROPY OF TH RESISTANCE CHANGE OF n-CONDUCTING InSb.

H.Rupprecht.

Z. Naturforsch. (Germany), Vol. 16a, No. 4, 395-401 (April, 1
In German.

Crystals grown by the Czochralski method and containing excess of 10^{16} cm^{-3} often show anisotropy of resistance for ex magnetic fields of various orientations to the growth direction resistance change for current parallel to the growth direction order of magnitude higher than for current perpendicular to th growth direction. This was established for growth directions [100], [113]. With suitable drawing speeds the anisotropy can avoided. These results can be understood on the assumption t the impurity centres are incorporated in layers with variable concentration perpendicular to the growth direction. The expe mental results are in agreement with Herring's theory.

F.Ans

14472

ILLUMINATION RECOMBINATION OF HOLES AN ELECTRONS IN PbS, PbSe, PbTe. N.S.Barÿshev

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1428-30 (May, 1961)

The temperature dependence of interband irradiation recombination in semiconductors of the PbS group was studie the basis of the van Roosbroeck—Shockley theory. The therm equilibrium recombination velocity and lifetime of excess ele and holes was evaluated in the interval 77°-522°K. It was sho that the effective recombination cross-section is practically constant above room temperature, being 1.3×10^{-19}, 8×10^{-2} 2.2×10^{-19} cm^2 for PbS, PbSe and PbTe respectively. [Englis translation in: Soviet Physics—Solid State (USA)]. D.J.

14473

PHASE TRANSITION IN MERCURY TELLURIDE. J.Blair and A.C.Smith.

Phys. Rev. Letters (USA), Vol. 7, No. 4, 124-5 (Aug. 15, 1961

An abrupt change in the resistivity of mercury telluride observed at a pressure of about 15 000 kg cm^{-2} at room tempe ature. The resistivity change was essentially reversible by a of 10^4 to 10^5, the law pressure resistivity being 1.5×10^{-3} ohm The change is ascribed to a transition between two polymorphic phases of the material. C.H

14474

ELECTRICAL CONDUCTIVITY AND THERMODY EQUILIBRIUM IN NICKEL OXIDE. S.P.Mitoff.

J. chem. Phys. (USA), Vol. 35, No. 3, 882-9 (Sept., 1961).

The electrical conductivity of nickel oxide was studied at temperatures between 600° and 1350°C and partial pressures oxygen between 1 atm and 10^{-4} atm. The slope of log conduct versus reciprocal temperature plots increases when the temp ture is high enough for the sample to come into thermodynam equilibrium with the atmosphere, and the temperature at whic change in slope occurs is observed to depend on the rate of he or cooling of the crystal. The heat of formation of nickel vac may be determined from the magnitude of the change in slope simple calculation. Nickel oxide is a p-type semiconductor i which the conductivity is proportional to the concentration of ions in the lattice. When thermodynamic equilibrium is estab with the atmosphere the conductivity is proportional to the $\frac{1}{6}$t power of the oxygen partial pressure. The analysis of the co mechanism and the conduction data may be self-consistently ated with nickel diffusion, nickel vacancy diffusion, and weigh changes resulting from equilibration with different oxygen pa pressures. The following constants may be determined from correlations: heat of formation of nickel vacancies, activatio energy for nickel vacancy migration, activation energy for ele hole migration, and concentrations of nickel vacancies and Ni ions as a function of temperature and oxygen pressure. Com results give the following for the concentration of nickel vaca $0.11\,(P_{O_2})^{1/6}\exp(-17\,800/RT)$ vacancies per ion pair.

14475

STRUCTURE, ELECTRICAL AND THERMOELEC PROPERTIES OF $SnSe_2$.

G.Busch, C.Fröhlich F.Hulliger and E.Steigmeier.

Helv. phys. Acta (Switzerland), Vol. 34, No. 4, 359-68 (1961).
In German.

Single crystals of the semiconducting compound $SnSe_2$ we prepared by sublimation and by the Bridgman technique. X-r analysis showed the structure of the undeformed compound to

· CdI_2 type with a = 3.811 A, C = 6.137 A. Resistivity and Hall
measurements lead to an energy gap of 1 eV. Investigations
· Seebeck effect and thermal conductivity were carried out
· range 240° to 370° K. Energy flux by radiation through the
al was found to enhance the thermal conductivity appreciably.

niconductor Devices

1476

STUDY OF THE EFFECT OF ILLUMINATION AND TEMPERATURE ON AN ISOLATED P—N JUNCTION.

Boutry and M.Robert.
Acad. Sci. (France), Vol. 252, No. 17, 2540-2 (April 24, 1961).
ench.

Theory predicts a rapid increase in the open-circuit voltage
loped when the junction is weakly illuminated, as the temper-
is lowered and this is confirmed by experiment with a
anium photodiode. C.A.Hogarth

477

AN ACCUMULATION PHENOMENON IN COOLED GERMANIUM P—N JUNCTIONS.

svignes and M.Robert.
Acad. Sci. (France), Vol. 252, No. 18, 2693-5 (May 3, 1961).
ench.

An isolated junction subject to illumination acquires rapidly
itive polarization (see preceding abstract). However, if the
ion has initially an inverse polarization, it will discharge
a time constant which may become very large at low temper-
. A theory of these phenomena is sketched and it is pointed
at the long time constant may allow detection of very faint
signals. L.Pincherle

1478

ON THE REVERSE CHARACTERISTICS OF GERMANIUM JUNCTION DIODES.

rinczy and G.Pataki.
phys. Hungar., Vol. 13, No. 1, 67-73 (1961).

These were examined in the temperature range of 200°-340° K.
s found that the reverse current — instead of showing
ation — changes linearly with the voltage. On the basis of
emperature dependence of the slope of the linear section a
hesis made on the shunting effect of the adsorbed water
of some molecules seems to be justified. Below 0° C an
ation energy of 9.1 kcal/mol appears as the conductivity of
in good agreement with the corresponding data figuring in the
ature. From the temperature dependence of the defined
ation current a value of 0.70 eV was derived as the gap of
anium.

479

ELECTRICAL CHARACTERISTICS OF DIFFUSED InAs P—N JUNCTIONS. G.Lucovsky.

J. appl. Phys., Vol. 12, No. 6, 311-12 (June, 1961).

Indium arsenide p—n junctions were prepared by diffusing
ium into the n-type material. Graphs are shown of forward
everse currents against bias voltage and of barrier capacitance
st barrier potential. The latter is a straight line of slope
) μμf/V. Deviations of the results from conventional diode
y are briefly discussed. R.Parker

1480

SLOW SURFACE CONDITIONS ON PbS MONOCRYSTALS.

L.N.Sȳrnev.

Acad. Bulg. Sci., Vol. 14, No. 2, 139-42 (1961). In Russian.

An investigation of the slow relaxations of the reverse current
hotocurrent of point diodes from PbS revealed that only those
nsibilized PbS crystals possess a slow effect. The greater
hoto-sensitivity of the diodes, the more pronounced the slow
t in them. The slow relaxations of the reverse and the
current are the same but with an opposite sign. An analysis of
ation curves shows that they can be viewed as composed of two
nential processes with a relatively wide transition between
. The time constants of these two processes lie respectively
n the limits 0.1-0.5 sec. and 10-20 sec. Water vapour increases
uration of the latter exponential process without modifying its
constant. The conclusion drawn from the asymmetry of the
relaxations obtained from an increase and reduction of the
ge is that the transition to the slow levels is effected by the
. The results obtained can best be explained by means of
ison's model of electronic transitions. [Phys. Rev. (USA),
99, 1655 (1955)].

14481

MAGNETODIODES.

É.I.Karakushan and V.I.Stafeev.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 677-86 (March, 1961).
In Russian.

The presence of a magnetic field has a marked influence on the volt—ampere characteristics of semiconductor diodes. This is treated theoretically for cathodes of various geometry for both high and low values of index. The magnetic field influences the length of the diffusing region and the concentration of the carriers limiting the conductivity of the diode. Experimental determination of volt—ampere characteristics broadly confirms the theory. A form of magnetodiode promising a 200 times increase in current for a magnetic field of 19 300 Oe is proposed. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 493-8 (Sept., 1961)].
A.E.I. Research Laboratory

14482

TEMPERATURE DEPENDENCE OF LOW FREQUENCY FLUCTUATIONS OF CONDUCTIVITY IN REVERSE-BIASED GERMANIUM P-N JUNCTIONS. Yu.S.Karpov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1571-3 (May, 1961).
In Russian.

An experimental investigation of l.f. noise at 75 c/s with an amplifier bandwidth of 8 c/s is described. It is shown that shot and thermal noise (the latter due to the diode load resistor) can be neglected. While a rise of noise with temperature is predictable, mainly due to rising leakage current, the smaller increase at temperatures below 0° C supports the theory propounded by Watkins (Abstr. 2327 of 1959), that this f^{-1} noise is due to avalanche multiplication of carriers sited in the junction regions at the outer surfaces. A number of measurements is plotted and discussed in detail. [English translation in: Soviet Physics—Solid State (USA)].
A.Landman

14483

SOME ELECTRICAL PROPERTIES OF ZINC TELLURIDE-CADMIUM SULFIDE HETEROJUNCTIONS.

M.Aven and D.M.Cook.

J. appl. Phys. (USA), Vol. 32, No. 5, 960-1 (May, 1961).

Describes two methods of preparing junctions between n-CdS and p-ZnTe. Fused In and evaporated Au formed the respective ohmic contacts. The current—voltage characteristic appears to be dominated by ohmic leakage or by generation—recombination in the depletion layer at forward or reverse voltages less than a few tenths of a volt, by ohmic series resistance at forward voltages of around 2 V, and by the onset of breakdown at higher reverse voltages. Rectification ratios of 10^2 to 5×10^4 have been obtained. F.F.Roberts

14484

NOISE IN InSb PHOTODIODES.

B.R.Pagel and R.L.Petritz.

J. appl. Phys. (USA), Vol. 32, No. 10, 1901-4 (Oct., 1961).

Noise generation in InSb infrared photodiodes was investigated. Minimum noise occurs when the diode is biased to zero potential. Noise spectra taken on seven photodiodes determined the white noise level above 1 kc/s. The experimental value of white noise is compared with the noise induced by random fluctuations in background radiation. The photonoise is calculated from

$$\langle i^2\rangle/\Delta f = 2qI_{PH}$$

for an equivalent noise generator. The photoinduced current I_{PH} is measurable directly for zero bias potential. The total measured white noise is of the order of one decibel above the calculated photoinduced noise, which is thus the primary source observed, and InSb photodiodes closely approach the ideal condition of background-limited infrared detectors.

14485

1/f NOISE AND CHANNEL IN Ge p—n JUNCTION.

K.Komatsubara, Y.Inuishi, H.Edagawa and T.Shibaike.

J. Phys. Soc. Japan, Vol. 15, No. 9, 1713-14 (Sept., 1960).

The suggestion that the channel at the surface of a Ge p—n junction is concerned in the generation of 1/f noise observed for reverse bias, is verified by field effect and optical injection experiments. C.A.Hogarth

14486

ELECTRICAL PROPERTIES OF HEAVILY DOPED N-TYPE GERMANIUM. Y.Furukawa.

J. Phys. Soc. Japan, Vol. 15, No. 10, 1903-4 (Oct , 1960).

The influence of simultaneous doping of germanium with As and Sb on the V—I characteristics of Esaki diodes, measured at 4 2° K, appears to be consistent with differences of impurity scattering.
G.C.Williams

14487 INDIRECT TRANSITION IN NARROW JUNCTION OF Ge—Si ALLOY. K.Ando.
J. Phys. Soc Japan, Vol. 15, No. 12, 2360 (Dec., 1960)

From observations of the fine structure of V—I characteristics of abrupt p-n junctions at liquid He temperatures an attempt is made to investigate phonon—lattice interactions and the tunnelling mechanism. G.C.Williams

14488 A NOTE ON THE METHOD OF DETERMINING IONIZATION COEFFICIENTS FOR ELECTRONS AND HOLES IN SILICON. R.J.McIntyre.
J. Electronics and Control (GB), Vol. 9, No. 3, 229-31 (Sept., 1960).

Recent measurements have shown that the breakdown voltages of symmetrical p^+n and pn^+ silicon alloy junctions are the same. This was interpreted in terms of equal ionization coefficients (Abstr. 5714 of 1959). The present paper shows the simple analysis used in arriving at this conclusion to be wrong and points out that a further experiment to measure the pre-breakdown current multiplication is necessary to find both ionization coefficients explicitly and accurately. I.Cooke

14489 THE GENERAL CONDITION FOR THE ABRUPT INCREASE OF THE INVERSE CURRENT OF A P—N JUNCTION IN THE ZENER REGION. M.Drăgănescu.
Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 3, 753-64 (1960).
In Roumanian.

14490 A NEW DEVICE USING THE TUNNELING PROCESS IN NARROW P—N JUNCTIONS. L.Esaki and Y.Miyahara.
Solid-State Electronics (GB), Vol. 1, No. 1, 13-21 (March, 1960).

The design, fabrication and electrical characteristics of a new device made of heavily doped silicon or germanium for use as an active circuit element, are discussed. The device is essentially a single, narrow p—n junction made by alloying techniques, and the d.c. negative resistance in its characteristics arises from a tunnelling process across the junction, which makes the device inherently capable of working at very high frequency. The device, which is simple in construction and stable even in high humidity, is promising for low-level, high-speed switching, oscillation and amplification.

14491 PHYSICAL PRINCIPLES OF THE ESAKI DIODE AND SOME OF ITS PROPERTIES AS A CIRCUIT ELEMENT. R.A.Pucel.
Solid-State Electronics (GB), Vol. 1, No. 1, 22-33 (March, 1960).

A brief description is given of the physical mechanism underlying the operation of the recently invented, negative-resistance "tunnel" diode. This diode, which is capable of operation at microwave frequencies, is then analysed from a circuit viewpoint. On the basis of this analysis, an equivalent circuit of the diode is obtained with the help of which are calculated such useful design criteria as the maximum frequency of oscillation and the maximum gain-bandwidth product, and the minimum noise figure, when the diode is used as an oscillator and amplifier, respectively. Experimental results are quoted which verify many of these quantities.

14492 AVALANCHE INJECTION DIODES. A.F.Gibson and J.R.Morgan.
Solid-State Electronics (GB), Vol. 1, No. 1, 54-69 (March, 1960).

A high-speed two-terminal negative-resistance device is described. A quantitiative theory of the diode characteristics is developed and compared with experimental units.

14493 A METHOD OF MAKING NEGATIVE-RESISTANCE TWO-STATE SWITCHING DIODES. C.A.Hogarth.
Solid-State Electronics (GB), Vol. 1, No. 1, 70-4 (March, 1960).

It is shown that an assembly consisting of a point contact bearing on a surface made heavily n-type by diffusion of phosphorus into a 20 ohm cm n-type silicon crystal, possesses a voltage—current characteristic typical of the avalanche injection diodes described by Gunn and by Gibson and Morgan (see preceding abstract).

ELECTRONIC DETERMINATION OF THE I, G, AND I/G PARAMETERS OF A TUNNEL DIODE. See Abstr. 13051

14494 NEW, THERMALLY VARIABLE BEAD RESISTOR. V.J.Tennery and R.G.West.
J. appl. Phys. (USA), Vol. 32, No. 7, 1402 (July, 1961).

Ferroelectric barium titanate, doped with La, Sm, Gd, Ho or Nb, is a semiconductor exhibiting an anomalous increase in resistivity when heated through the tetragonal—cubic transition temperature, which temperature can be shifted by partial substitution of Pb or Sr for Ba. Sintered bead thermistors fabricated from $Ba_{0.85}Sr_{0.15}TiO_3$(La) possess unusual voltage—current characteris due to operation in the positive temperature coefficient regi resistivity at low power and in the negative temperature co region of resistivity at higher power. The device is denote (PN)TC thermistor. J.

14495 SEMICONDUCTING STRESS TRANSDUCERS UTILIZING THE TRANSVERSE AND SHEAR PI RESISTANCE EFFECTS. W.G.Pfann and R.N.Thurston.
J. appl. Phys. (USA), Vol. 32, No. 10, 2008-19 (Oct., 1961).

Outlines the principles of a varied group of new semic piezoresistive stress and strain transducers, which have in the utilization of the transverse or shear piezoresistive eff group of devices consists of gauges in the form of a thin re sheet bonded to the test piece, whose resistance change can expressed as a simple function of the principal stresses in gauge. Two special gauges in this group are described. In resistance change is proportional to the aum of the principa stresses for any orientation of the gauge on the test piece. other, the resistance change is proportional only to longitud stress components, being independent of transverse stress ents. Also described are a four-terminal gauge for the com determination of biaxial stresses, full-bridge gauges made single crystal, load cells of low compliance, new torque tra and diffusion techniques for making some of the foregoing. devices are illustrated in terms of germanium and silicon b extension to other semiconductors is straightforward.

14496 NATURE OF AN OHMIC METAL-SEMICONDUC CONTACT. G.Diemer.
Physica (Netherlands), Vol. 26, No. 11, 889 (Nov., 1960).

Offers an explanation for the behaviour of ohmic contac between n-type CdS crystals and In electrodes. J

14497 HALL EFFECT FOUR-POLE WITH HIGH EFFI G.Arlt.
Solid-State Electronics (GB), Vol. 1, No. 1, 75-84 (March 19
In German.

The upper efficiency limit of the Hall gyrator with four is 0.17. To increase the efficiency more than one polarizing circuit and Hall circuit has to be soldered to the same Hall This holds for all types of Hall devices such as generator, g isolator, circulator, etc. Methods are given for the calculat the highest possible efficiency and other interesting propert Gyrators and isolators are proposed for audio, high and ultr frequency applications. Series—parallel connection of gyrat transformator yields a low-loss uniline.

Photoconductivity

14498 CROSS-SECTION RATIOS OF SENSITIZING CEN IN PHOTOCONDUCTORS. R.H.Bube.
J. appl. Phys. (USA), Vol. 32, No. 9, 1707-9 (Sept., 1961).

The ratio of the capture cross-section of a sensitizing c for a photoexcited hole to the subsequent capture cross-secti a free electron, in n-type photoconductors, can be determine the measurement of the thermal quenching of photoconductivi a function of excitation intensity. The magnitude of the ratio information about the charged state of the sensitizing centre. summary of many such measurements on seven different pho conductors of type II—VI or III—V supports the hypothesis th doubly charged sensitizing centres are present in some of th materials, but that singly charged sensitizing centres are pr in the majority.

14499 OPTICAL INTERFERENCE AND INTERNAL PHOTOEFFECTS IN THIN PHOTOCONDUCTIVE LAYERS. D.Kossel and W.Schmidt.
Naturwissenschaften (Germany), Vol. 48, No. 3, 67-8 (1961).
In German.

Since the optical absorption and similar properties of th films is an interference function of the film thickness, the photoconduction is also expected to show periodic variations increasing film thickness. Experiments with Sb_2S_3 layers sh these effects as predicted by simple theory. C.A.

THE DETERMINATION OF CERTAIN PARAMETERS OF SEMICONDUCTOR FROM THE SLOPE OF THE SPECTRAL RESPONSE OF THE PHOTOCONDUCTIVITY. See Abstr. 14

)0 THE ROLE OF THE SPATIAL REDISTRIBUTION OF CHARGE IN THE KINETICS OF THE INTERNAL)EFFECT OF HIGH-RESISTANCE PHOTOCONDUCTORS.

ershberg.
'erdogo Tela (USSR), Vol. 3, No. 5, 1384-92 (May, 1961).
sian.

he kinetics of the internal photoeffect (photoconduction) in
b_2Se_3 in the time interval 10^{-3}-1 sec were compared under
ions differing widely from the point of view of the role of the
l redistribution of charge. Since, during the transition from
perimental conditions to another, the relaxation process is
not changed or not changed significantly, it was concluded
e spatial redistribution of the charge carriers is of secondary
tance. The strong dependence of the inertia of photoconduction
voltage applied to a layer, found in certain cases, is caused
tact phenomena. According to preliminary experiments, the
behaviour appies not only to $Sb_2S_3.Sb_2Se_3$ but to a large group
stances. [English translation in: Soviet Physics—Solid State
]. D:J.Huntley

01 THE INCORPORATION OF Cu IN $CdIn_2S_4$ PHOTO-CONDUCTORS. H.Koelmans and H.G.Grimmeiss.

a (Netherlands), Vol. 27, No. 6, 606-8 (June, 1961).

he crystal structure of a number of alloys in the ternary
n $CdS-In_2S_3-Cu_2S$ were determined. The important result is
Cu activation of $CdIn_2S_4$ the monovalent Cu replaces divalent
h trivalent In also replacing Cd to give charge neutrality.
crystals of $CdIn_2S_4$ were made and the absorption coefficient
ired. Cu gives an extra absorption on the low energy side.
D.J.Oliver

02 PHOTOCONDUCTION IN CADMIUM SULPHIDE.

J.F.Duncan and D.N.Sitharama Rao.
J. appl. Phys., Vol. 12, No. 9, 511-13 (Sept., 1961).

iscrete voltage pulses, of amplitude depending on the energy
incident radiation were observed in the photoconduction of
um sulphide at room temperature. Between 4800 A and
the pulse height varies in a similar manner to the photo-
nt with wavelength. Below 3500 A it is closely proportional
energy of the radiation. Cadmium sulphide can be used as a
ophotometric device in this region when only small numbers
nta are available.

503 ON THE ROLE OF ELECTRODES AND NON-SYMMETRICAL ILLUMINATION IN THE INVESTIGA-OF PHOTOELECTRIC PROPERTIES OF CdS MONOCRYSTALS.

ev [Kŭnev] and R.Pirinchieva.
Acad. Bulg. Sci., Vol. 13, No. 6, 669-72 (Nov.-Dec., 1960).
ssian.

nvestigation of the potential distribution on CdS monocrystals
he use of metal probes (compensation methods, measurements
oint conductors, etc.) shows that the presence of intermediate
lic electrodes can result in considerable errors unless the
tial increase of these electrodes is allowed for. This is
cularly true when the illumination of the crystal is not
ıetrical. F.Lachman

504 THE QUESTION OF INFRARED QUENCHING OF PHOTOCONDUCTIVITY IN SINGLE CRYSTALS OF CdS.

erdyuk.
verdogo Tela (USSR), Vol. 3, No. 4, 1229-31 (April, 1961).
ssian.

is shown that heating CdS crystals can produce additional
in the photosensitivity spectrum, the shape of the band
ding on the heat treatment. The quenching of the photocurrent
d in single crystals by irradiation in these bands is examined
unction of infrared wavelength. Two peaks are found in the
hing spectrum, one at 0.95 μ and the other at 1.45 μ, whose
itudes depend on the excitation wavelength. The possible use
s quenching phenomenon as a basis for an infrared detector is
sted. [English translation in: Soviet Physics—Solid State (USA),
, No. 4, 892-3 (Oct., 1961)]. K.N.R.Taylor

505 EFFECT OF HEAT-TREATMENT UPON SINTERED CADMIUM SULPHIDE PHOTOCONDUCTIVE FILMS.

amura.
s. Soc. Japan, Vol. 15, No. 9, 1697 (Sept., 1960).

dS photoconductive films prepared by the $CdCl_2$ flux method
sintered on to a fused quartz plate with evaporated gold elect-
. When heated in vacuum at the rate of 1 deg C/min the dark
nt at 100 V d.c.was reversible with temperature below 90°C
rreversible above this temperature. Conductivity plotted against 1/T (°K) for films heated in vacuum at 160°C showed that the activation energy decreased to 1/20th of its initial value, while curves of thermal stimulation current against temperature showed a peak at room temperature and a trap concentration increased by 20 times.
W.Steckelmacher

14506* PHOTOCONDUCTIVITY OF Cu-ACTIVATED CADMIUM SULPHIDE-SELENIDE. S.Asano.

J. Phys. Soc. Japan, Vol. 15, No. 11, 2103 (Nov., 1960).

A study of the spectral response of photoconductivity in Cu-activated Cd(S:Se), and its variation with composition, gives information on the energy gap and band structure. The change in level of the trapping centres results in a variation of the photocurrent decay time with composition. P.A.Walker

14507 ANOMALOUS PHOTOVOLTAIC EFFECT OF CdS SINGLE CRYSTALS.

S.Ibuki, H.Komiya and H.Yamashita.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2356 (Dec., 1960).

CdS single crystals, grown by sublimation recrystallization in a N_2 atmosphere containing In, were half-covered with evaporated Cu, and both ends soldered with In metal. The cells showed an anomalous photovoltaic effect, the polarity of the photo-induced open-circuit voltage being reversed at low light intensities. The short-circuit current at constant light intensity also varied with temperature and changed polarity. The effect is attributed to the superposition of the two phenomena due to the p—n junction and to an electron diffusion current. J.B.Birks

14508 ENHANCEMENT OF PHOTOCONDUCTIVITY UPON CADMIUM SULPHIDE SINGLE CRYSTALS.

S.Kitamura, T.Kubo and T.Yamashita.
J. Phys. Soc. Japan, Vol. 16, No. 2, 351 (Feb., 1961).

Infrared produces quenching of photoconductivity if the electric field is 750 V/cm or 1250 V/cm. At 2000 V/cm the photocurrent is enhanced. The peak enhancement or quenching occurs at 900 and 1400 mμ. The phenomenon is not understood. D.J.Oliver

14509 EFFECT OF VACANCIES ON PULSE PHOTOCONDUCTIONS IN CdS SINGLE CRYSTALS.

J.Shirafuji and Y.Inuishi.
J. Phys. Soc. Japan, Vol. 16, No. 4, 832 (April, 1961).

The effect of stoichiometric defects on the decay time constants and photocurrent, of pulsed photoconductivity in CdS single crystals was observed as a function of temperature. J.B.Birks

14510 STRUCTURES OF PHOTOCONDUCTIVITY SPECTRA NEAR THE FUNDAMENTAL ABSORPTION EDGE OF CADMIUM SULFIDE. H.Mitsuhashi.

J. Phys. Soc. Japan, Vol. 16, No. 5, 989-95 (May, 1961).

The photoconductivity structures of CdS single crystals near the adsorption edge were investigated using polarized light at about 81°K. Field dependence of wavelengths of peaks and spectral dependence of decay time of the response were measured. From these experimental results, the structures are classified into two groups, one is attributed to the photoconductivity due to excitons which occur in the shorter wavelength range ($\lambda < 4870$ A) and the other to that from some imperfections involved in the crystal, which appear on the longer wavelength side.

14511 INVESTIGATION OF THE PHYSICAL PROPERTIES OF OHMIC AND NON-OHMIC CONTACTS ON CdS MONO-CRYSTALS. H.I.Holy̆nna, H.A.Fedorus and M.K.Sheinkman.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 593-605 (1959). In Ukrainian.

A comparative study was conducted on the properties of ohmic and non-ohmic contacts and the effect of these properties on certain stationary and kinetic characteristics of photoconductivity. A method was developed for obtaining an ohmic contact on moncrystals of CdS, CdSe and CdS_x. $CdSe_{1-x}$ ($x < 1$) by treating the subelectrode surface of the crystals in a glow discharge with subsequent vaporization of aluminium. A number of characteristics of these contacts were investigated at various temperatures. Conclusions are drawn on the basis of the data obtained as to the mechanism which secures their ohmic characteristics.

14512 PHOTOVOLTAIC EFFECTS IN Cs_3Sb FILMS.

F.Wooten.
J. appl. Phys. (USA), Vol. 32, No. 9, 1789-90 (Sept., 1961).

The effects were obtained on films 200 to 500 A thick by scanning with a small light spot. The voltages were always associated with the illumination of imperfections on the film. There was some evidence for the enhancement of photoemission from these imperfections. D.J.Oliver

14513 PHOTO- AND SEMICONDUCTION IN CRYSTALLINE CHLOROPHYLLS a AND b.

B.Rosenberg and J.F.Camiscoli.
J. chem. Phys. (USA), Vol. 35, No. 3, 982-91 (Sept., 1961).

Measurements are reported on some characteristics of photoconduction and semiconduction in pure crystalline chlorophylls a and b. The semiconduction activation energy is 1.12 eV in chlorophyll a and 1.44 eV in chlorophyll b (E/2kT). The latter value is in excellent agreement with the triplet state energy of 1.43 eV measured by the phosphorescence method in chlorophyll b. The former value suggests that a possible cause of the lack of detectable phosphorescence in chlorophyll a is that it occurs in the infrared at about 11 000 A. The evidence indicates that the mobility of the predominant charge carriers (positive holes) is the same in both crystals. Photoconduction is easily measured in chlorophyll b and less easily in chlorophyll a, because of the much larger dark current. The photoconduction activation energy in chlorophyll b is 0.36 eV. This supports Rabinowitch's view that photoconduction in chlorophyll is not involved in the primary act of photosynthesis. The oxygen adsorbed on the surface of the crystals forms an oxygen—chlorophyll complex. This leads to an increase in both the dark current and the photocurrent probably by increasing the mobility of the surface charge carriers. There is no detectable effect of oxygen upon the semiconduction activation energy, since the increase of the magnitude of the current is small (a factor of 4 to 10). The binding energy of the oxygen—chlorophyll a complex is about 1.4 eV; that of the oxygen—chlorophyll b complex 0.63 eV. There is no detectable activation energy for the formation of the complex. It is not a photo-oxidation process. Some evidence suggests that a more tightly bound oxygen complex exists which has no effect on electronic conductivity. This more stable complex is converted by light into the weakly bound complex described above (probably by photoreduction of chlorophyll in the complex). These results are similar to those of Arnold and Sherwood's work on dried chloroplasts. They favour their alternative explanation - that of an oxygen compound being responsible for thermoluminescence and a thermal spike in conductivity - rather than their first assumption, that of electron trapping and recombination in chlorophyll itself.

PHOTOCONDUCTIVITY OF DIAMONDS. See Abstr. 14210

14514 QUANTITATIVE PHOTOVOLTAIC EVALUATION OF THE RESISTIVITY HOMOGENEITY OF GERMANIUM SINGLE CRYSTALS.

J.Oroshnik and A.Many.
Solid-State Electronics (GB), Vol. 1, No. 1, 46-53 (March, 1960).

An apparatus, based on the bulk photovoltaic effect, is described by means of which quantitative estimates of the resistivity changes throughout germanium single-crystal samples may be realized. The experimental technique consists of scanning the sample with a light spot and recording the photovoltage, or integrated photovoltage, versus position of the light spot. By taking into account the magnitudes of the photovoltages and photoconductance upon illumination, the resistivity changes can be derived from the scans of integrated-photovoltage versus position. For germanium of 10 ohm cm resistivity or less, the changes in resistivity determined by the use of this system are usually within 30% of the actual changes determined with the two-point probe. For material that is homogeneous in lifetime, the error may be as little as 3%. With this technique, single-crystal wafers may also be explored so as to determine sections of best uniformity. The method is essentially non-destructive.

14515 LOCAL SENSITIVITY OF PbS PHOTORESISTORS.

M.N.Markov and É.P.Kruglyakov.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 538-40 (Oct., 1960).
In Russian.

There were numerous peaks and "valleys" of photosensitivity distributed randomly across the PbS sample surface. At the contacts the sensitivity was three times higher (and the sensitivity threshold three times lower) than in the middle of PbS photoresistors. A further lowering of the sensitivity threshold could be obtained by taking the signal from the illuminated region only and not from the whole sample. The photosensitivity peaks occurred at grain boundaries and were accompanied by high local resistivities. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 284-5 (Oct., 1960)]. A.Tybulewicz

14516 PHOTOVOLTAIC RESPONSE OF SELENIUM BARRIER LAYER CELLS TO X-RADIATION IN THE ENERGY RANGE OF 15-40 keV.

R.Feinberg and G.E.Rhead.
Brit. J. appl. Phys., Vol. 12, No. 9, 461-4 (Sept., 1961).

Twenty selenium barrier-layer cells, made by a modern commercial process with a variety of modifications, were ex by irradiation of X-rays in the 15-40 keV energy range and t behaviour was compared with their response to light. The X sensitivity is found to be independent of intensity of irradiati constant X-ray tube anode voltage, but linearly proportional anode voltage at constant anode current. The form of transi response to X-irradiation depends on the intensity of irradia the previous history of cell irradiation, a time of rest of abo being required to achieve the "first-irradiation" response. fatigue effect does not occur in the steady-state values to ph voltage and photocurrent. There is some evidence for a qua relationship between X-ray and optical photovoltage sensitiv of a cell, but there is no relationship between the photocurre sensitivities.

14517 ELIMINATION OF THE EFFECT OF NON-PHOT CONDUCTIVE LAYERS IN STUDIES OF PHOTO-CONDUCTIVITY OF MERCURY-BEARING AMORPHOUS SELENIUM FILMS.

M.I.Korsunskii, N.S.Pastushuk and G.D
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1366-70 (May, 196
In Russian.

It was shown that the anomalous character of the lux—a characteristics of amorphous Se films, subjected to the actic Hg vapours, is due to the existence of a non-photoactive com of resistivity. A method was developed for determining the mag of this component from the lux-ampere characteristics, constr in the form $1/\Delta\sigma_m = \varphi[1/f(I)]$. With the aid of this expedient variation of photoconductivity of Hg-bearing Se films can be lished. [English translation in: Soviet Physics—Solid State (M.H

14518 INVESTIGATION OF THE STATIONARY PHOTO CONDUCTIVITY AND SURFACE RECOMBINATI VELOCITY OF SILICON.

Yu.A.Kontsevoi and M.I.Iglitsyn.
Fiz. tverdovo Tela (USSR), Vol. 3, No. 5, 1465-74 (May, 196
In Russian.

Some possibilities of measuring the surface recombinat velocity in Si are discussed on the basis of the theory of the stationary photoconductivity and the different methods compa The dependence of the photoconductivity of thin films on the intensity of illumination with different surface treatments an different gas atmospheres was investigated and reasons for discovered departure from linearity discussed. [English tra in: Soviet Physics—Solid State (USA)]. D.J

14519 BULK PHOTOELECTROMAGNETIC EFFECT IN NON-HOMOGENEOUS SEMICONDUCTOR.

S.Sikorski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No.
371-8 (1960).

Illumination of a specimen of semiconducting material possessing a resistivity gradient gives rise to a difference c potential across the specimen which is known as the bulk photovoltaic effect (BPV). If the same specimen is placed ir magnetic field an additional electric field is produced perpe lar in direction to both the magnetic field and the field due t BPV. The author develops a theoretical expression for this additional field which he terms the bulk photoelectromagneti effect (BPEM). In particular the case of a thin rectangular semiconducting plate is considered. A preliminary experim investigation is also reported and satisfactory agreement be theory and experimental results is claimed; i.e., the ratio o electric field due to BPEM to a field related to BPV is calcu to be 0·26 and found by experiment to be 0·27. F.

14520 RELAXATION POLARIZATION IN DIELECTRIC THE INTERNAL FIELD IN CRYSTALS AND POL CRYSTALLINE MATERIALS.

G.I.Skanawi.
Proc. Math. Phys. Soc. UAR (Egypt), No. 23, 43-63 (June, 19
In German.

A review of the considerations which led to the developn the strontium/bismuth titanates (Abstr. 8759 of 1956) — cer with high permittivities but which are not ferroelectric. A n for deducing internal field coefficients from dielectric meas ments is described, but no illustrations are given. Data up t 10^{10} c/s for Sr, Ca, Zn and Mg titanates are reported which absorption regions at still higher frequencies. Work on orga polar solids and dielectric measurements on some alkali ha mentioned, the latter confirming the work of Breckenridge (1231 of 1949). K.W.

521 **PHOTO-IMPEDANCE OF THE AgCl ELECTRODE SYSTEM.** D.A.Wiegand.
. Rev. (USA), Vol. 124, No. 1, 104-14 (Oct. 1, 1961).

Che observed frequency response of the AgCl-electrode m indicates an equivalent parallel combination of capacitance onductance in series with the bulk photoconductance. The ge dependence of the capacitance suggests an exhaustion , presumably at the sample-electrode interface, and the itude of the capacitance indicates that the layer is thick. tatively, the dependence of the layer capacitance and current e intensity and wavelength of the exciting illumination, on erature, and on voltage can then be understood in terms of ential barrier. Alternatively, the results can be described ms of layers, presumably at the surface, of lower conductivin the bulk. An increase of the capacitance with the bulk ctivity, and so with the density of mobile electrons, suggests he positive charge in the exhaustion region is determined at in part by holes generated by illumination. The dependence bulk photoconductivity on temperature, voltage, intensity, avelength are discussed.

ermoelectric Properties

522 **CALCULATIONS OF THE THERMOELECTRIC PARAMETERS AND THE MAXIMUM FIGURE OF T FOR ACOUSTICAL SCATTERING.** L.R.Testardi.
l. Phys. (USA), Vol. 32, No. 10, 978-81 (Oct., 1961).

Che calculations of Chasmar and Stratton (Abstr. 4374 of 1960) termine the maximum thermoelectric figure of merit are ded in the case of acoustical scattering. Graphical data are nted for the material parameter, the optimum values of several ities, and the degradation of the figure of merit for non-optimum tions. The variations of the Seebeck coefficient and the rical conductivity computed from exact statistics are compared xperiment for several alloys of thermoelectric interest. agreement is found except in the case of high electrical conities. Other anomalies are noted.

523 **REMARK ON THE SEEBECK COEFFICIENT OF POLAR SEMICONDUCTORS.** J.Appel.
Mag. (GB), Vol. 6, 167-9 (Jan., 1961).

n equation is derived for the Seebeck coefficient α of a polar onductor to which the small polaron picture applies, and this des an explanation of the measured temperature dependence of the Ce—S semiconductors. C.A.Hogarth

524 **ON THE EXPERIMENTAL DETERMINATION OF THE THERMOELECTRIC EFFICIENCY OF SEMI-UCTORS.** U.Birkholz.
-State Electronics (GB), Vol. 1, No. 1, 34-8 (March, 1960).
rman.

Che technical use of the thermoelectric effects has been icable for some years, since the development of special semictors. The efficiency of thermoelectric generators, as well e coefficient performance of Peltier refrigerators and the icient for reversible heating, are determined by the same rial constant, the figure of merit z. This magnitude is obtained solute thermoelectric power α, electric conductivity σ and al conductivity κ according the equation $z = \alpha^2\sigma/\kappa$. A method scribed by means of which α, σ and κ are ascertainable in the of room temperature by use of a single piece of apparatus; s of measuring arising by heat radiation, as well as inhomoty of the samples, are discussed.

525 **THE NATURE OF THE THERMAL E.M.F. ARISING AS A RESULT OF METAL DEFORMATION.**
ertsriken, M.M.Novÿkov and V.S.Kopan'.
yin. fiz. Zh. (USSR), Vol. 4, No. 3, 293-9 (1959). In Ukrainian.

The phenomenon of a thermal e.m.f. arising in a couple rising deformed—undeformed metal has long been known. ver, despite the relatively numerous researches along these no connection has as yet [January 1959] been established en the thermal e.m.f. and the crystal lattice defects arising g deformation. On the basis of a comparison of the curves ing the dependence of the thermal e.m.f. and the value of the ive volume variation during the annealing of the deformed ls on the value of the deformation and annealing temperature, uthors found that the thermal e.m.f. arising in a couple of med—undeformed metal must be completely ascribed to the crystal lattice defects arising during deformation — particularly, to vacancies, dislocations and dislocated atoms. Applying the previously found ratio between the number of defects and the magnitude of the deformation of the specimen, the e.m.f. per dislocation and per vacancy is determined. Employing the thermodynamic expression for the connection between the thermal e.m.f. with the Thomson and Peltier e.m.f.'s, as well as the analytical expressions of these parameters, the authors establish the fact that the main cause of the thermal e.m.f. arising during deformation of the metal is the increase in its resistance, due to the formation of crystal lattice defects during deformation. The relative change in Thomson's e.m.f. during deformation of the metal is also determined.

14526 **REVIEW OF STUDIES OF THE THERMOELECTRIC PROPERTIES OF GROUP I METALS AT LOW TEMPERATURES, CARRIED OUT IN THE NATIONAL RESEARCH COUNCIL LABORATORIES AT OTTAWA.**
U.B.Pirson [W.B.Pearson].
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1411-24 (May, 1961).
In Russian.

After a general review of the subject, experiments on group I metals made during the last few years are discussed. Among these topics are measurements down to 0.05°K on alkali metals and the effect of impurities on the maximum in the thermopower due to phonon drag; the effect of impurities (especially iron) on the thermopower of the noble metals and the influence of cold-work. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

14527 **THE THERMOELECTRIC POWER OF IONIC CRYSTALS. I. THEORETICAL.**
A.R.Allnatt and P.W.M.Jacobs.
Proc. Roy. Soc. A (GB), Vol. 260, 350-69 (March 7, 1961).

The theory of the thermoelectric power of solid ionic conductors has been considered thermodynamically by Holtan, Mazur and de Groot (Abstr. 2448 of 1954) and kinetically hy Howard and Lidiard (Abstr. 2340; 4039 of 1958). In the thermodynamic treatment the defective structure of the solid was ignored and consequently the gradient of chemical potential of the salt components was equated to zero. In the kinetic treatment, the existence of defects was recognized, but vacancies were treated as species of effective unit charge moving in a uniform dielectric. In this paper the theory of the homogeneous thermoelectric power of an ionic crystal is reformulated in a rigorous manner, vacancies being treated as separate thermodynamic species with zero charge and mass. The equation for entropy production is derived for the case of an ionic crystal containing defects. The theory requires expressions for the chemical potentials of ions and defects; inaccuracies in previous discussions are pointed out and the correct expressions for the chemical potentials are given. A new theory of the heterogeneous thermoelectric power is developed and a possible experimental test of this indicated.

14528 **PELTIER COEFFICIENT AT HIGH CURRENT LEVELS.** J.R.Reitz.
J. appl. Phys. (USA), Vol. 32, No. 8, 1623-4 (Aug., 1961).

The importance of forming ohmic contacts to the semiconductor elements used in high-current Peltier junctions is discussed.
A.J.Fox

THERMOELECTRIC POWER OF CHROMIUM SULPHIDES.
See Abstr. 14465

14529 **THERMOELECTRIC POWER OF SINGLE CRYSTALS OF GALLIUM.** P.Horner.
Nature (GB), Vol. 191, 58-9 (July 1, 1961).

Three gallium single crystals were grown from seed by passing a freezing plane through the super cooled melt in such a manner that the rod axes were aligned along the (100), (010), and (001) crystallographic axes respectively. The variation of the Seebeck e.m.f. with temperature, and the absolute thermoelectric powers ($Q = A + BT$), were then found to be: $1.46 + 0.000_2\,T$, $2.44 + 0.009_2\,T$, and $1.10 + 0.000_7\,T$ respectively. The anisotropic ratios of the coefficients A are not as large as those of the electrical or thermal conductivity, while B being practically zero for the (100) and (001) axes indicates their Thomson coefficients $T(dQ/dT)$ to be zero for the range of temperature considered. H.H.Hodgson

14530 **MEASUREMENTS OF THERMOELECTRIC POWER IN InSb.** J.Ginter and W.Szymańska.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron.phys. (Poland), Vol. 9, No. 5, 419-21 (1961).

Describes precautions taken to eliminate systematic experimental errors which arise when the thermoelectric power α of specimens of high thermal conductivity, e.g., InSb. is measured. The variation of α with T for five specimens with carrier concentrations in the range 1.5×10^{15} to 9.6×10^{17} cm^{-3} is plotted but no analysis of the results is given. G.C.Williams

14531 THE THERMOELECTRIC POWER OF MAGNESIUM—CADMIUM ALLOYS. S.Noguchi.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1145-50 (June, 1961).

The thermoelectric power of magnesium—cadmium alloys was measured relative to pure copper at temperatures between roon temperature and 300°C. The measurements were made in the entire ranges of the composition and the data were analysed by a band-model approximation to obtain some information about the band structure of the alloys in the magnesium—cadmium system. The thermoelectric power at 300°C as a function of composition shows a smooth trend as well as that of an earlier investigation of the Hall measurements (Abstr. 12417 of 1961), although the result of the thermoelectric power at room temperature shows that there are three maxima and two minima, while the result of the Hall coefficient gives two maxima and one minimum. In the alloys of the composition corresponding to the ordered phase, anomalies in the thermoelectric power are observed at the transition point. The results of the thermoelectric power indicate that there is no evidence of any extinction or initiation of a band by the alloying. The situation of the Fermi level in A-overlap is discussed.

14532 THERMOELECTRIC POWER OF TITANIUM- AND VANADIUM- CARBIDES. S.Noguchi and T.Sato.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2359 (Dec., 1960).

Thermoelectric power measurements at room and liquid nitrogen temperatures are used to determine the Fermi energy and the number of conduction electrons in titanium and vanadium carbide. P.A.Walker

14533 NON-CALORIMETRIC METHOD FOR MEASURING THE RELATIVE VALUES OF PELTIER'S COEFFICIENT ON THE BOUNDARY OF A METAL WITH METALS OR SEMICONDUCTORS. P.I.Barans'kyi.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 472-8 (1959). In Ukrainian.

The method is described in some detail and its advantages, as compared with earlier known calorimetric methods, are analysed.

Dielectric Properties

14534 THE MAGNITUDE OF THE ANHARMONIC CONTRIBUTION TO THE STATIC DIELECTRIC CONSTANT.

B.Szigeti.

Proc. Roy. Soc. A (GB), Vol. 261, 274-80 (April 25, 1961).

It is shown that in ionic crystals the anharmonic contribution to the static dielectric constant can be calculated above the Debye temperature if the derivatives of the dielectric constant with respect to temperature and pressure are known. The necessary data are available for three alkali halides. For these, the anharmonic contribution is found to amount to a few parts per cent of the total lattice contribution.

14535 DIPOLAR ABSORPTION. I. NON-STOICHIOMETRIC OXIDES AND SULPHIDES. II. ADSORPTION OF WATER ON VARIOUS MINERAL SUBSTANCES. III. DOUBLE ARSENATE OF AMMONIUM AND THALLIUM.

Jean Le Bott, M.L.Blanchard, A.Baron, Y.Colin, Dang Tran Quan, G.Grosvald and Jac.Le Bot.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 25-7, 27-8, 28-9 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The paper summarizes very briefly studies of dielectric absorption in the following materials. (1a) ZnO. The low temperature conductivity below 200° K is assigned to electrons and due to excess Zn in interstitial positions. The conductivity at temperatures greater than 200° K is related directly to the presence of vacancies of Zn. Evidence for this comes from the results of heating in Zn vapour. The dipolar relaxation is probably due to the association of an anion vacancy with a cation vacancy. Disappearance of the absorption band on heating in oxygen or Zn vapour supports this. (1b) CdO. Free carriers make the usual methods unusable but dipolar relaxation is indicated. (1c) MnS. Some preliminary experiments are reported. A dipolar relaxation band at 140° K and 10 kc/s was found which could be intensified or reduced by heat treatment. (2) Adsorption of water on aluminous cement. Two absorpti bands were found in the anhydrous product and a third appea hydration. The study of the setting of Portland cement by di methods is reported. Ionic substituted kaolinites showed dip relaxation due to adsorbed water. (3) The double arsenate ammonium and thallium showed an intense dipole relaxation 118° K independent of frequency. R.G.C.

14536 STUDY OF THE DIELECTRIC PROPERTIES OF ZINC SULPHIDE FILMS.

R.Fuchshuber, R.Guillien and S.Roizen.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 30-3 (196 In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Evaporated films sandwiched between aluminium electrodes prepared in a vacuum of 10^{-7} mm Hg and stabilized by subm to an intense field for a short time. A modified Schering bri was used. The value of tan δ increased rapidly with tempera but was reduced by reheating. The results were interpreted Maxwell—Wagner process rather than a Debye one.

R.G.C.

14537 DIELECTRIC LOSSES IN RELATION TO STRUC OF IONIC CRYSTALS.

N.P.Bogoroditskii, B.A.Kulik and I.D.Fridberg.

Izv. Akad. Nauk SSSR, Ser.fiz., Vol. 24, No. 2, 137-41; Disc. (1960). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 1600 1960). Studies of ionic relaxation losses in the halides of so potassium, lithium and caesium and in isovalent alkali-halid mixtures at audio and radio frequencies at 200-300°C showe these losses are high in loosely packed lattices, in defect s solutions, in substitutional solutions with admixtures, and in substitutional solid solutions in the process of decompositio

A.Tyb

MOLECULAR ROTATIONAL RELAXATION IN LIQUIDS SOLIDS. See Abstr. 12898

14538 AN INVESTIGATION OF RELAXATION POLARIZ AND PHASE COMPOSITION OF THE $SrTiO_3$—$Bi_2O_3 \cdot nTiO_2$ (n = 2,3) SYSTEM.

A.M.Kashtanova, N.N.Kurtseva and G.I.Skanavi.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 2, 114-23; Disc. (1960). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 1600 of 1960). X-ray diffraction and microscopic studies showed $Bi_2O_3 \cdot nTiO_2$ (up to 10 mol.%) formed cubic solid solutions in strontium titanate. Above 10 mol.% $Bi_2O_3.nTiO_2$(bismuth tita a new phase appeared: it consisted of a complex bismuth tita with strontium in its lattice. This new phase was accompani a sharp fall of permittivity. Studies of the temperature depe of permittivity and tan δ confirmed non-ferroelectric relaxat polarization (ϵ up to 1000) in all samples except those with predominant bismuth titanate composition; the latter had low permittivity and exhibited no relaxation polarization.

A.Tyb

14539 RELAXATION POLARIZATION OF THE SYSTEM $SrTiO_3.nMnO$ (n = 1,2,3) E.V.Sinyakov and A.M.

Izv. Akad. Nauk SSSR, Ser.fiz., Vol. 24, No. 2, 132-4; Disc. (1960). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 1600 1960). Studies of the temperature dependence of permittivity tan δ showed ionic relaxation polarization in $SrTiO_3.nMnO$, e tronic relaxation polarization in $Bi_2O_3.nMnO$ (due to transitic of weakly bound electrons between Mn^{2+} and Mn^{3+}) and both and electronic relaxation polarization in $SrTiO_3.n(Bi_2O_3.MnO$

A.Tyb

14540 DIELECTRIC ANISOTROPY OF BLOCKS OF PA AT HYPERFREQUENCIES. R.Servant.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 35-7 (196 In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). made up from leaves of paper show strong birefringence at wave frequencies according as the electric vector lies paral perpendicular to the leaves. The fibres of cellulose are re sible for this as in thick cartons and in wood. For most pape the specific polarization (Gladstone) is constant. Interpretat in terms of the conception of chains of water molecules with hydrogen bonds, bonded to the cellulose molecules.

R.G.C.

4541 THE PROBLEM OF THE DIELECTRIC LOSSES AND PERMITTIVITY OF GLASSES AT VERY HIGH QUENCIES. M.D.Mashkovich.

tverdogo Tela (USSR), Vol. 3, No. 4, 1105-9 (April, 1961).
ıssian.

ϵ and tan δ were measured for seven glasses in the range · 3.75 × 10^{10} c/s at temperatures from 20° to 400°C. There is ıcrease in tan δ above ~ 10^{9} c/s, suggesting a new loss mechan- In the cm-wave region the temperature variation still shows es of low-frequency relaxation processes. [English translation Soviet Physics - Solid State (USA), Vol. 3, No. 4, 804-6 ., 1961)]. R.Berman

14542 MEASUREMENTS OF THE PERMITTIVITY OF SOLIDS AS A FUNCTION OF TEMPERATURE. INTERPRETA- OF EXPERIMENTAL CURVES IN DIFFERENT CASES.

Montagner.
Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 18-24 (1960).
ench.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The ts of temperature on Debye type dipolar relaxation and on well—Wagner interfacial polarization are examined theoretically n relation to experimental results. Reference is also made to eresis effects in ferroelectrics. See also following abstract and r. 11738 of 1960. J.H.Mason

14543 DIPOLAR RELAXATION PHENOMENA AS A FUNCTION OF TEMPERATURE. S.Le Montagner.

nys. Radium (France), Vol. 21, No. 7, 609-14 (July, 1960).
rench.

The Debye dipolar relaxation equations are examined taking erature as the variable. Theoretical curves ϵ(T) are predicted, ewhat different from the classical one ϵ(ω), chiefly in the ons where $\partial\epsilon_s/\partial T < 0$, i.e. near a phase transition. Two onium alums were used to make an experimental check.

4544 THE POSSIBILITY OF OBTAINING ANISOTROPIC ARTIFICIAL DIELECTRICS. K.Leibler.

Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 34 (1960).
ench.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). npts to orient aluminium powder dispersed in dielectrics are rted. An ultrasonic field was applied to a dispersion in the d phase and the dielectric then frozen in the field. The system obtained showed dielectric anisotropy. Differences in dielectric tant with direction, of 10% for paraffin—aluminium and 15% for styrene—aluminium were found. R.G.C.Arridge

4545 SIMULTANEOUS INVESTIGATION OF THE PHOTO-DIELECTRIC EFFECT AND THE LIGHT SUM IN THE Cu:Co PHOSPHOR. G.M.Malkin.

tverdogo Tela (USSR), Vol. 3, No. 2, 575-7 (Feb., 1961).
ussian.

Measurements made at room temperature at different decay s show that in ZnS:Cu:Co no parallelism exists between the ease in stored radiation and $\epsilon_0 - \epsilon_\infty$. This indicates that in Cu:Co the photodielectric effect is determined mainly by uction electrons. See also following abstract. [English trans-n in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 422-3 ., 1961)]. Z.Krasucki

4546 INVESTIGATION OF THE RELAXATION TIME OF PHOTODIELECTRIC EFFECT IN THE ZnS:Cu:Co SPHOR. G.M.Malkin.

tverdogo Tela (USSR), Vol. 3, No. 2, 578-80 (Feb., 1961).
ussian.

Changes in the relaxation time with decay of phosphorescence the dependence of the relaxation time on temperature, after tation at 20°C, verify the hypothesis put forward by Vergunas Malkin (Abstr. 1129 of 1961) that in ZnS:Cu:Co the photodielectric t is determined by conduction electrons. [English translation oviet Physics—Solid State (USA), Vol. 3, No. 2, 424-5 (Aug.,)]. Z.Krasucki

4547 THE POSSIBILITY OF THERMAL POLARIZATION OF ELECTRONS IN ZINC SULPHIDE PHOSPHORS.

Vergunas and P.E.Ramazanov.
Akad. Nauk SSSR, Ser.fiz., Vol. 24, No. 2, 214-19; Disc. 242-5 0). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of). Studies of the temperature dependence of the photodielectric effect (rise of permittivity and tan δ on illumination with ultraviolet light) in ZnS:Cu:Fe phosphors showed that this effect was produced by thermal polarization of electrons localized at centres lying 0.52 eV below the conduction band. A.Tybulewicz

14548 THE STATISTICAL THEORY OF FERRO- AND ANTIFERROELECTRICS. V.I.Klyachkin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 373-81 (Feb., 1961).
In Russian.

The existing theory of ferro- and antiferroelectrics based on Boltzmann statistics fails to account for the evident temperature dependence of the atomic parameters. In the present paper the methods of Landau and Lifshits' "Statistical Physics" are applied to the case in which only one chemical sub-lattice is displaced from the equilibrium position. This representation, although crude, not only simplifies the analysis greatly but also permits establishment of a physical criterion for the origin of ferroelectricity in crystals, and comparison of it with experiment determines the limits of applicability of the model. The results of such an analysis for barium titanate are compared with experimental data. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 271-8 (Aug., 1961)]. J.M.Taylor

14549 MODELS FOR SWITCHING IN FERROELECTRICS. D.J.White.

J. appl. Phys. (USA), Vol. 32, No. 6, 1169 (June, 1961).

Three current models for the polarization reversal during switching are considered: (1) random nucleation and sidewise motion of 180° domains; (2) three-dimensional switching; (3) the model of Fatuzzo and Merz (Abstr. 1694 of 1960). From the equations for polarization as a function of time, the following criteria of validity are established:

For model 1	$1.213\, P_s/T_m \le J_m \le 2.047\, P_s/T_m$
	$0.3935 \le P_m/2P_s \le 0.4868$
For model 2	$2.047\, P_s/T_m \le J_m \le 2.834\, P_s/T_m$
	$0.4868 \le P_m/2P_s \le 0.5276$
For model 3	$0 \le J_m T_m \le 0.736\, P_s$
	$0 \le P_m/2P_s \le 0.2642$

where J_m is the maximum value of switching current, T_m the time to maximum current, and P_m the polarization at T_m. The parameters J_m, T_m and P_m may be determined from the experimental switching transient, and since the criteria are mutually exclusive, the possible model selected. L.E.Cross

NUCLEAR QUADRUPOLE RESONANCES; PHASE CHANGES AND FERROELECTRICITY OF ALKALI IODATES.
See Abstr. 14833

14550 SOME REMARKS ON THE PHENOMENOLOGICAL THEORY OF FERROELECTRICITY.

S.Sawada and I.Yoshida.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1322-7 (July, 1961).

The free energy of a ferroelectric is expanded as an even power-series of polarization in the customary phenomenological theory. For the case of the transition of the second order, the condition is examined under which the well-known relation holds that the temperature-gradients of reciprocal susceptibility immediately below and above the transition point stand in the ratio −2 : 1, and it is shown that this relation is valid regardless of the number of terms taken in the expansion and the temperature-dependence of their coefficients. When the transition is of the first order, on the contrary, this ratio is found to be very sensitive to them, though a simple ratio −8 : 1 is obtained by postulating the temperature-independent coefficients of fourth- and sixth-powers and neglecting terms of higher powers. A similar result is also obtained concerning antiferroelectricity.

14551 DIELECTRIC CONSTANTS AND LOSS TANGENTS OF (GLYCINE)$_3$ H_2SO_4 (T.G.S.) AT 3.3 kMc/s.

E.Nakamura and J.Furuichi.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2101 (Nov., 1960).

ϵ' and tan δ were measured on TGS at 3.3 kMc/s from room temperature to 80°C. A rectangular cavity operating in the TE_{105} mode was used with a cylindrical specimen, its axis lying in the direction of the field. The values of ϵ' and tan δ for the temperature range 20-80°C are compared with ϵ' at 1 Mc/s over the same range. ϵ' at 3.3 kMc/s is not appreciably lower than at 1 Mc/s except near the Curie point (~ 50°C). It is concluded that the relaxation frequency should show a minimum at the Curie point as in Rochelle salt. R.G.C.Arridge

14552 DOMAIN STRUCTURE OF $NaNO_2$.

S.Nomura, Y.Asao and S.Sawada.
J. Phys. Soc. Japan, Vol. 16, No. 5, 917-23 (May, 1961).

The 180° domains along the b direction in $NaNO_2$ single crystals were observed by the etching method at room temperature. The domain boundaries lie parallel to (100). The virgin crystal prepared from the aqueous solution is almost a single-domain, but, after having once been heated above the Curie temperature, it has nearly the same domain structure as the crystal prepared from the melt. These domains were ascertained to be the ferroelectric ones from experiments with d.c. field. By the alkali etchant the positive end of the domain was more rapidly etched than the negative one, and nearly the contrary result was obtained for the acid etchant. The fact that the domain boundaries lie parallel to (100) is intimately related with the thermal motion of NO_2^- radicals.

14553 PERFECTNESS OF MACRODOMAINS OF $BaTiO_3$ CRYSTALS.

K.Aizu and O.Nakada.
J. Phys. Soc. Japan, Vol. 16, No. 5, 923-7 (May, 1961).

Statistico—thermodynamical investigation is made on the size and density of reversely-polarized microdomains contained within a unidomain c-plate (or a macrodomain of a multidomain c-plate) of $BaTiO_3$ in thermal equilibrium at room temperature, with or without a constant electric field applied. Microdomains treated here are confined to ones running through the crystal plate from the surface on the one side to the surface on the other side. It is found that a thinner crystal plate contains more reversely-polarized microdomains, and a plate thicker than about 2×10^{-6} cm contains practically no reversely-polarized microdomains. Reversely-polarized microdomains tend to disperse rather than coalesce, and can hardly be depressed by an electric field. Just below the Curie temperature, it is expected that the critical thickness is considerably larger than the above value, since the domain-wall energy per unit area is fairly small.

14554 EFFECTS OF GAMMA-RAY IRRADIATION ON ROCHELLE SALT.

K.Toyoda, A.Kawabata and T.Tanaka.
Bull. Inst. Chem. Res. Kyoto Univ. (Japan), Vol. 39, No. 2, 189-94 (March, 1961).

It was found that the ferroelectric region became narrower as a result of irradiation, and that ferroelectricity disappeared after prolonged irradiation. The most striking change appears in the ferroelectric hysteresis loop, i.e. a double loop pattern in the irradiated crystal. It was also found that the piezoelectricity was affected as a result of irradiation.

14555 FERROELECTRIC PROPERTIES OF X-RAY DAMAGED ROCHELLE SALT.

K.Okada.
J. Phys. Soc. Japan, Vol. 16, No. 3, 414-23 (March, 1961).

Radiation damage effects by X-rays in rochelle salt were studied experimentally and theoretically. A double hysteresis loop is explained as a superposition of two biased single loops. Each biased single loop corresponds to each of the two oppositely polarized domains, of which the crystal is composed. Single domain crystals show biased single loops when damaged, and the internal bias this induced can be compensated by an external d.c. biasing field. But the Curie point of the damaged crystals compensated by this suitable external field is lower than that of the virgin by ΔT, which depends upon the X-ray dosage. In this respect the effect of damage differs from that of the stress. It is assumed that the irradiation gives rise to polar anisotropy centres which produce effective bias fields in undamaged ferroelectric regions. Irradiation time dependences of the spontaneous polarization, the coercive field and the internal bias are studied. A phenomenological theory is developed to explain the various phenomena. The polarization within the polar anisotropy centre is estimated to be the order of 100 e.s.u. near the shifted Curie point.

14556 THE FERROELECTRIC PHASE TRANSITION IN $(GLYCINE)_3 . H_2SO_4$ AND CRITICAL X-RAY SCATTERING.

I.Shibuya and T.Mitsui.
J. Phys. Soc. Japan, Vol. 16, No. 3, 479-89 (March, 1961).

On the assumption that the ferroelectric phase transition in $(Glycine)_3 . H_2SO_4$ is of the order—disorder type, expressions for Bragg reflections and critical scattering of X-rays are given in terms of a long-range order parameter and pair correlation functions. Temperature dependence of the critical scattering is discussed on the basis of the Bragg—Williams approximation and of a modified Fröhlich theory [Theory of Dielectrics. London: Oxford University Press (1958) Chapter II, para. 7]. Experimental
observations agree with theoretical predictions, and prove th
the phase transition is of the order—disorder type. The obs
critical scattering exhibits a pronounced peak at the Curie p
suggesting that the local field theory is not a good approxima
The shape of the peak appears to be quite different from that
ferromagnetic case. It has been found that the S atoms do n
appreciably when the glycine groups rotate. A method for ev
the pair correlation function is proposed.

14557 X-RAY STUDIES OF THE FERROELECTRIC PH TRANSITION IN $NaNO_2$.

I.Shibuya.
J. Phys. Soc. Japan, Vol. 16, No. 3, 490-4 (March, 1961).

Studies of the temperature dependence of Bragg reflecti
and critical scattering of X-rays were carried out for ferroe
$NaNO_2$ in a manner analogous to those made by Shibuya and
for $(glycine)_3 . H_2SO_4$ (see previous abstract). Experimental o
tions agree with theoretical predictions which are based on a
assumption that the phase transition in $NaNO_2$ is of the order
disorder type. A long-range order parameter and the sponta
polarization are estimated as functions of temperature by us
temperature variation of Bragg reflections. The observed in
of the critical scattering drops rather abruptly just above the
Curie point in a manner similar to the case of $(glycine)_3 . H_2S$

14558 FERROELECTRICITY IN (K, NH_4), (K, Rb) AND FERROCYANIDE MIXED CRYSTALS.

S.Waku, K.Masuno and T.Tanaka.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1158-61 (June, 1961).

Substitutions of the potassium ion in potassiun ferrocyan
the other monovalent positive ions were examined. Substitue
produce isomorphous ferroelectric substances through repla
some part of the K ion were found to be NH_4, Rb and Tl ions
ively. The peak of the dielectric constant versus temperatur
shifts to the low temperature side by increasing the amount o
substituents. Substituted compounds containing a relatively s
amount of these substituents show ferroelectric behaviour si
that of potassium ferrocyanide trihydrate.

14559 THE MOVEMENT OF SINGLE 90° DOMAIN WAL $BaTiO_3$ IN AN ALTERNATING ELECTRIC FIELD

J.Fousek and B.Březina.
Czech. J. Phys., Vol. 10, No. 7, 511-28 (1960).

Single crystals of $BaTiO_3$, containing one 90° domain wall
used to study the origin and character of the movement of suc
wall in an alternating electric field having a frequency of 50 c
The experimental results are discussed from the phenomenol
point of view.

14560 NEW FERROELECTRICS WITH COMPLEX COMPOSITION. IV.

G.A.Smolenskii, V.A.Isupov, A.I.Agranovskaya and N.N.Krai
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2982-5 (Nov., 196
In Russian.

For Pt III see Abstr. 638 of 1960. New perovskite-type
ferroelectrics are reported with compositions represented b
$(Bi_{0.5}Na_{0.5})TiO_3$ and $(Bi_{0.5}K_{0.5})TiO_3$ and Curie temperatures of
320° and 380°C respectively. Lattice sites with coordination
numbers equal to 12 were occupied by Na^+, K^+ and Bi^{3+} ions.
nature of the chemical bond in these and other compounds an
effect on spontaneous polarization are discussed. [English
translation in: Soviet Physics—Solid State (USA)]. A.Tybu

14561 SURFACE LAYER IN $BaTiO_3$ SINGLE CRYSTALS

E.Fatuzzo and W.J.Merz.
J. appl. Phys. (USA), Vol. 32, No. 9, 1685-7 (Sept., 1961).

The switching time and the coercive field in ferroelectri
$BaTiO_3$ are known to depend on crystal thickness. A model a
following lines is proposed to explain the experimental result
the crystal surface there is a thin layer of electrically biased
mechanically strained $BaTiO_3$ which has a much smaller diel
constant than the bulk. It is proposed that the electrical bias
the mechanical strains in the surface are caused by a Schottk
exhaustion layer. This model and the model proposed by Dro
and Landauer are discussed and their predictions are compar
with experimental results.

14562 DIELECTRIC RESONANCE IN FERROELECTRIC TITANATES IN THE MICROWAVE REGION.

A.L.Stanford, Jr.
Phys. Rev. (USA), Vol. 124, No. 2, 408-10 (Oct. 15, 1961).

The dielectric spectra of $BaTiO_3$ and $(Ba, Sr)TiO_3$ were

sured in the microwave region from 250 to 7000 Mc/s in the
electric and paraelectric regions. The dispersion near
Mc/s is shown to exhibit a resonance character near the
e temperature.

THE AGEING PROCESS IN TITANIUM-CONTAINING
AMICS BY MEANS OF ELECTRON PARAMAGNETIC
ONANCES. See Abstr. 12659

4563 SOME THEORETICAL IDEAS ON NON-UNIFORM DISTRIBUTION OF ELECTRIC FIELD DURING
AKDOWN. K.V.Bër [K.W.Boer].

Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 1, 43-8; Disc. 91-3
0). In Russian.
"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of
). Application of an electric field produced ring-shaped
regions near the cathode in crystals illuminated with mono-
matic light of the fundamental edge wavelength. These regions
interpreted as non-uniformities of the electric field distribu-
where free carriers are produced. Local high fields produce
breakdown conditions which eventually lead to total breakdown.

A.Tybulewicz

4564 BREAKDOWN IN SOLID DIELECTRICS. R.Rompe.

ndl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech.
many), 1960, No. 1, pp.5-6. In German .[Colloquium on
mogeneous Fields in Solid Dielectric in The Breakdown Region].
Introductory paper. The pre-breakdown phase, whose study is
terest to the physicist in connection with the movement of
rons at high fields, is distinguished from destructive phase, of
est to the engineer. Factors of importance in the destructive
e are inhomogeneities in the current path, high, high-tempera-
mechanical properties of the dielectric, etc.

K.W.Plessner

14565 THE INFLUENCE OF FIELD EMISSION [FROM THE CATHODE] ON THE DISTRIBUTION OF STRONG FIELDS
OLIDS. E.I.Adirowitsch.

ndl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech.
many), 1960, No. 1, 9pp. In German. [Colloquium on
nogeneous Fields in Solid Dielectrics in the Breakdown Region].
A summary of a published paper (Abstr. 1666 of 1960).

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

4566 OPTICAL STUDIES OF SPIRALS ON SYNTHETIC QUARTZ CRYSTALS. M.S.Joshi and S.Tolansky.

. Roy. Soc. A (GB), Vol. 260, 475-80 (March 21, 1961).
An account is given of optical and interferometric studies on
al patterns which have been found on the basal planes of syn-
c quartz crystals. These patterns have high visibility and show
single and interlaced triangular spirals, of but a few turns, and
ys enclosed within a linear boundary. The topographies of the
als are studied with the help of a new, highly sensitive, accur-
contouring, thin-film multiple-beam interference technique
h is described. The spirals differ in character from the usual
th spirals, being in effect shallow ruts running round hillocks,
proposed that these spirals arise from an etching or solution
nanism.

4567 THE EFFECT OF CONSTANT ELECTRIC AND MAGNETIC FIELDS ON THE OPTICAL PROPERTIES
UNIAXIAL CRYSTALS WHERE EXCITONS ARISE.

.Tsvirko.

ayin. fiz. Zh. (USSR), Vol. 4, No. 5, 654-63 (1959). In Ukrainian.
The effect on the exciton energy level structure is considered.
ations are obtained for the frequency dependence of the
rence of the indexes of refraction $n_1(\omega)-n_2(\omega)$. It is shown
in some special cases of crystal symmetry, constant fields
lead to splitting or shifting of the exciton absorption line.

4568 INFRARED TRANSMITTANCE OF CRYSTALLINE YTTRIUM OXIDE AND RELATED COMPOUNDS.
Wickersheim and R.A.Lefever.

pt. Soc. Amer., Vol. 51, No. 10, 1147-8 (Oct., 1961).
Clear single crystals of yttrium oxide, ytterbium oxide and a mixed yttrium–lanthanum oxide were grown by a flame fusion process. The transmission of an yttrium oxide plate 1.89 mm thick fell to 50% at about 8.0 microns wavelength. Yttrium oxide will accept trivalent metal ions into its lattice and is a potential infrared maser material.

J.N.Hodgson

14569 OPTICAL CONSTANTS AND STRUCTURE OF THIN FILMS. P.Bousquet and P.Rouard.

J. Phys. Radium (France), Vol. 21, No. 12, 873-92 (Dec., 1960). In French.

It is recognized to-day that thin films, either transparent or absorbing, have a structure and, therefore, optical constants that are different from those of the corresponding bulk material. Numerous investigations have been directed during the last decade to the determination of these optical constants and to the theoretical interpretation of the results obtained. These investigations are reviewed in this article and a critical examination is made of them.

14570 THE OPTICAL PROPERTIES OF SINGLE CRYSTALS OF CADMIUM SELENIDE.

R.B.Parsons, W.Wardzynski and A.D.Yoffe.

Proc. Roy. Soc. A (GB), Vol. 262, 120-31 (June 13, 1961).

Cadmium selenide is a semiconductor with interesting optical and photoconductive properties in the red part of the spectrum. This paper is concerned mainly with the measurement of a number of the optical properties of cadmium selenide in which pure single crystals grown by sublimation in atmospheres of inert gas were used. Thin plates of CdSe less than 1 μ thick were obtained, and these are transparent right down to short wavelengths in the region of 4500 A. At liquid-helium temperatures, sharp absorption bands may be observed in the visible part of the spectrum, both in the red part near the absorption edge, and in the green part. From the position of these bands and the shape of the absorption curves, information has been obtained concerning the band structure. Two levels occur near the top of the valence band with a small energy separation (ca. 0.026 eV) and these are connected with crystal field splitting. The energy separation of the deeper levels is ~ 0.41 eV and these levels are thought to arise from spin-orbit interaction. Line spectra were also observed, and these are connected with levels (possibly exciton levels) close to the conduction band. The line spectra appear to be less complicated than those previously observed by Gross and Sobolev (1960). The bands and lines in CdSe appear near the optical absorption edge. Measurements have now been made for wavelengths near the absorption edge of the refractive indices and birefringence at temperatures down to liquid-helium temperature. The birefringence changes in an unusual manner in the wavelength region between the two bands in the red part of the spectrum. These results should be of use in a complete discussion of the optical properties of CdSe.

PROPERTIES OF HEAVILY DOPED N-TYPE GERMANIUM. See Abstr. 14441

14571 INFRARED TRANSMITTANCE OF STRONTIUM TITANATE FROM ROOM TEMPERATURE TO –180° C.

C.D.Salzberg.

J. Opt. Soc. Amer., Vol. 51, No. 10, 1149-50 (Oct., 1961).

The infra-red transmittance of single crystal strontium titanate was measured at temperatures between –187° C and 26° C. The absorption edge around 5 microns wavelength shifted only slightly between the extreme temperatures.

J.N.Hodgson

14572 THE DISPERSION OF LIGHT IN THE EXCITON ABSORPTION REGION IN CUBIC CRYSTALS. B.E.Tsekvava.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1164-75 (April, 1961). In Russian.

The connection between the polarization current and the electric field intensity is obtained. The normal and anomalous dispersion of light is calculated taking into account the anisotropy of the exciton effective mass in cubic crystals. [English translation in: Soviet Physics—Solid State (USA); Vol, 3, No. 4, 847-54 (Oct., 1961)].

K.G.Major

14573 REFRACTIVE INDEX AND PORE STRUCTURE OF ACID-LEACHED SURFACE LAYER OF GLASS.

K.Kinosita.

J. Phys. Soc. Japan, Vol. 16, No. 4, 807-18 (April, 1961).

It is known that acids leach out metal ions from the outermost layer of glass, leaving a skeleton film. The refractive index of such a film n_f was found to change with the relative humidity p/p_0, and n_f versus p/p_0 relations were studied for some dense flint and dense crown glasses. The following conclusions are derived from the analysis of n_f versus p/p_0 curves: (1) The refractive index of the skeleton n_s ($>n_f$) is always greater than that of fused silica, indicating that metal ions are still contained in the skeleton. (2) The porosity of the film ranges from 0.05 to 0.21, and the mean pore radius from 6 to 23A, depending on the composition of glass as well as the leaching conditions.

14574 DICHROISM AND BIREFRINGENCE OF SINGLE CRYSTALS OF CADMIUM SELENIDE. W.Wardzynski.

Proc. Roy. Soc. A (GB), Vol.260, 370-8 (March 7, 1961).

Single crystals of cadmium selenide were grown from the melt in vacuo. The coefficient of absorption, both for the ordinary and extraordinary beam, was measured over the wavelength range 0.73 to 2.0 μ. Dichroism was observed in the vicinity of the absorption edge. A method for the measurement of the difference between the refractive indices in cadmium selenide for the ordinary and extraordinary beam has been worked out. These measurements were carried out at room, and at liquid nitrogen temperatures. Birefringence was found to change from positive to negative near the absorption edge. Direct measurements of the refractive indices were carried out for the wavelength region 0.73 to 2.0 μ.

14575 BIREFRINGENCE OF A POLYSTYRENE SUBMITTED TO A CONSTANT PULLING FORCE. B.Persoz.

C.R. Acad. Sci. (France), Vol. 252, No. 21, 3189-91 (May 24, 1961). In French.

Results are given for a sample to which a tensile stress was suddenly applied and then maintained constant at various temperatures. Empirical expressions are given for the time t_0 taken for the Brewster coefficient to become zero and for the birefringence after any time. Values of t_0 are 4 min at 80°C, 5 hr at 70°C, 2 days at 60°C, 11 days at 50°C and 3 months at 30°C. Graphs showing the variation of birefringence with extension are shown.

H.G.Jerrard

14576 DISPERSION OF THE STRESS-OPTIC COEFFICIENT OF LITHIUM FLUORIDE. R.Srinivasan.

Naturwissenschaften (Germany), Vol. 48, No. 4, 96 (1961).

A graph showing the variation of the stress-optic coefficient C with wavelength is given for the range 2500 A to 5700 A. The values of C are correct to ±0.06 brewsters and the total dispersion of C amounts to 0.65 brewsters. The results were used to evaluate the constants in Mueller's equation for the strain-polarizability constant (Abstr. 3295 of 1935).

H.G.Jerrard

14577 THE FARADAY EFFECT OF FREE CARRIERS IN Bi_2Te_3 IN A WEAK MAGNETIC FIELD. F.G.Baksht.

Fiz.tverdogo Tela (USSR), Vol. 3, No. 1, 243-51 (Jan., 1961). In Russian.

The permittivity tensor of Bi_2Te_3 in an arbitrarily oriented magnetic field is calculated. Formulae are deduced for the rotation of the plane of polarization and for the degree of ellipticity of microwave and infrared radiation transmitted along the optical axis of a Bi_2Te_3 crystal when this axis coincides with the direction of the applied magnetic field. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 178-84 (July, 1961)].

A.Tybulewicz

14578 THE OPTICAL PROPERTIES OF CADMIUM TELLURIDE IN THE FAR INFRARED REGION.

A.Mitsuishi.

J. Phys. Soc. Japan, Vol. 16, No. 3, 533-7 (March, 1961).

The reflection spectra of CdTe were measured in the spectral region from 20μ up to about 400μ at the two different temperatures, 90°K and 300°K. The Reststrahlen band was found at 65μ with a peak reflectivity of 92% at 90°K and 67μ with a peak reflectivity of 77% at 300°K. The reflection spectra were analysed by Kramers—Kronig dispersion relation to obtain the optical constants n and k. Combining these values, the fundamental lattice dispersion frequencies of the bulk material were determined to be 140 cm^{-1} (71.2μ) at 300°K abd 144 cm^{-1} (69.5μ) at 90°K. The damping constant was also obtained.

14579 THE THEORY OF PHOTOEXCITATION IN SOLIDS. A.Meessen.

J. Phys. Radium (France), Vol. 22, No. 3, 135-41 (March, 1961). In French.

The theory of optical absorption is reviewed and further investigated. A distinction is shown between "oblique transitions" and "vertical transitions". They correspond to different selection rules and imply different physical processes. They are also characterized by distinct transition probabilities, and it appea that the oblique transition probability is not energy independen has been assumed. The calculation of the order of magnitude spectral distribution of the absorption in oblique and vertical transitions permits the following conclusions: (1) The absorp in a vertical transition is about a hundred times greater than oblique transition. (2) The fundamental absorption in insulato and semiconductors is due to a vertical transition. (3) Vertic transitions are forbidden in alkali metals. (4) Agreement betw observed and calculated photoexcitation absorption by oblique transitions is achieved to the right order of magnitude.

14580 ELECTRIC-FIELD-INDUCED MODULATION OF ABSORPTION DUE TO INTERBAND TRANSITION OF FREE HOLES IN GERMANIUM.

M.A.C.S.Brown and E.G.S.Paige.

Phys. Rev. Letters (USA), Vol. 7, No. 3, 84-6 (Aug. 1, 1961).

The absorption of light is due to interband transitions an directly dependent upon the distribution function of free holes the valence band. A study was made of the effect of high elec field upon this distribution function by measuring the change optical absorption of a p-type Ge sample between 90°K and 32 For comparison a similar experiment was performed in whic distribution function was changed by raising the lattice tempe It is suggested that the field effect could form the basis of mo ing a light beam at very high frequencies since the response not greater than 10^{-10} sec and a modulation depth greater tha 10% can be achieved with the lattice at 93°K.

A

STUDY OF THE MAGNETIC PROPERTIES OF IRON IN RELATION TO ITS COLOURING ACTION IN GLASS.
See Abstr. 14684

14581 LIGHT ABSORPTION BY F'-CENTRES IN IONIC CRYSTALS WITH A CUBIC LATTICE.

A.A.Ostroukhov and O.F.Tomasevy̆ch.

Ukrayin fiz. Zh. (USSR), Vol. 3, No. 4, 449-54 (1958). In Ukra

Calculated out on the basis of Pekar's polaron theory. T simplify the calculation it is assumed that the polaron escapi from the F'-centre does not polarize the crystal and is a free electron of effective mass μ. The values obtained for the pos of the maximum of the band, its form and motion with change temperature are in satisfactory agreement with the experime values. This agreement evidences the correctness of the ass that, on light absorption by the F'-centre, the final state of th electron system lies in the continuous, and not the discrete, spectrum.

14582 TEMPERATURE DEPENDENCES OF THE FUND MENTAL ABSORPTION TAIL OF KCl AND THE ABSORPTION DUE TO BROMINES IN KCl.

K.Kobayashi and T.Tomiki.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1417-22 (July, 1961).

Optical absorptions of the fundamental absorption tail of specially purified KCl and those due to bromine in KCl were measured between room temperature and 196°C. The latter estimated from the differences between the fundamental abso tails of pure KCl and KCl with bromine of concentration 1.3×10^{-4} per mole. Measured absorption coefficients were corrected by considering the effects due to the finite band wi the spectrometer. The fundamental absorption tail of KCl w found to be represented by the Urbach rule (Abstr. 2996 of 1 with $\sigma = 0.80 \pm 0.02$ and $h\nu_0 = 7.76 \pm 0.10$ eV. The long wave side of the bromine absorption was described by the same r where $\sigma = 0.51 \pm 0.03$ and $h\nu_0 = 7.35 \pm 0.15$ eV.

14583 ON THE OPTICAL ABSORPTION OF FILMS OF $PbCl_2$ AND THE SYSTEM TlCl-KCl. K.J.Best.

Z. Phys. (Germany), Vol. 163, No. 3, 309-20 (1961). In Gern

First, the optical absorption of amorphous films of PbCl formed by quenching condensation, is shown and compared to spectrum of $PbCl_2$ in its normal state. The sharp exciton ba crystalline $PbCl_2$ in the long wavelength region is considera broadened in the spectrum of amorphous films. The transiti from the amorphous state to the normal crystalline state is indicated by an abrupt, irreversible change in the absorption at 260°K. This comparatively high temperature seems to be to the complicated structure of $PbCl_2$. In the second part, th optical absorption curves of evaporated films of the system are measured. A shift of the absorption bands as a function composition is found. The 3.46-eV-maximum of pure TlCl i dinated to the A-band of the KCl:Tl-phosphor, but there is no ection between the 5.82-eV-maximum of TlCl and the known s of KCl:Tl.

ATOMIC ENERGY LEVELS IN CRYSTALS. See Abstr. 14148

4584

OPTICAL PROPERTIES OF IRRADIATED LiF CRYSTALS IN THE EXTREME ULTRAVIOLET.

ito.
. Inst. chem. Res. Kyoto Univ. (Japan), Vol. 39, No. 2,
7 (March, 1961).

A new absorption band at 11.1 eV was found at the tail of the amental absorption band. The oscillator strength of the is estimated to be about 0.25 on the assumption of a one-elec- centre. Behaviours of other absorptions which were observed e process of light bleaching of the F-band are also described discussions are given on the nature of the 222 mμ band.

4585

THE FUNDAMENTAL ABSORPTION OF LITHIUM FLUORIDE AND SODIUM FLUORIDE.

aka, A.Fukuda and A.Ejiri.
ys. Soc. Japan, Vol. 16, No. 2, 340 (Feb., 1961).

Optical absorption bands and transmissions are reported for evaporated films of lithium fluoride and sodium fluoride. The surements are carried down to wavelengths of 900 A. Strong rption bands are found in both fluorides. In lithium fluoride is an absorption peak at 12.7 eV. In sodium fluoride the peak ar to 10.7 eV. S.Tolansky

4586

A THEORY OF ELECTRONIC-VIBRATIONAL TRANSITIONS IN SYSTEMS WITH MANY VIBRATIONAL REES OF FREEDOM.

K.K.Rebane.
a i Spektrosk. (USSR), Vol. 9, No. 5, 557-63 (Nov., 1960).
ssian.

Gives a simple derivation of a formula for moments of a band o an electronic-vibrational transition in a crystal or in a cule. The expression obtained is identical with that reported ax (Abstr. 1247 of 1953). Lax's formula is shown to be valid when normal coordinates are not used to describe vibrations clei, when the distribution in vibrational levels is not an ibrium one, and when spectral bands consist partly or comly of lines. The theory is illustrated by the effect of omni- tional compression of crystal phosphors on the profiles of spectral bands. [English translation in: Optics and Spectrosc.), Vol. 9, No. 5, 295-8 (Nov., 1960)]. A.Tybulewicz

4587

ANOMALIES OF THE FARADAY EFFECT SHOWN AT RESONANCE BY VARIOUS FERRITES IN THE 10 kMc/s).

M.C.Vigneron.
Acad. Sci. (France), Vol. 253, No. 2, 251-3 (July 10, 1961).
ench.

Graphs are given showing ellipticity and Faraday rotation as ions of the magnetic polarizing field for rods of various types rrite in cylindrical waveguide. The curves exhibit anomalies rromagnetic resonance. R.A.Waldron

NTERMOLECULAR FORCES FROM OPTICAL SPECTRA OF RITIES IN MOLECULAR CRYSTALS. See Abstr. 14128

ABSORPTION OF CaF_2 MONOCRYSTALS. See Abstr. 14329

4588

OPTICAL ABSORPTION OF POLYCRYSTALLINE LAYERS OF CdS.

Shalimova, T.S.Travina and L.L.Golik.
. Akad. Nauk SSSR, Vol. 138, No. 1, 90-2 (May 1, 1961).
ssian.

The absorption spectrum of thin films of CdS was examined in avelength range from 200 mμ to 500 mμ. The films were ared by evaporation of the powder onto a substrate in vacuum atmosphere of argon and hydrogen sulphide. The substrate heated to various temperatures during the evaporation. Spectra shown and discussed for various film thicknesses and for rent preparation conditions. [English translation in: Soviet ics – Doklady (USA)]. K.N.R.Taylor

4589

EFFECT OF PRESSURE ON THE SPECTRA OF TRANSITION METAL IONS IN MgO AND Al_2O_3.

omura and H.G.Drickamer.
em. Phys. (USA), Vol. 35, No. 3, 903-7 (Sept., 1961).

The effect of pressure to 150 kbar was measured on the spectra of several transition metal ions in MgO and Al_2O_3. In general, there is an increase in crystal field strength with increasing pressure. The inter-electronic repulsion parameter decreased slightly with increasing pressure indicating a small increase in covalency. For Al_2O_3, Dq shifts as $(V_0/V)^{5/3}$ indicating that the R^{-5} law holds, and the local compressibility is the same as the bulk compressibility. In MgO the shift is always more rapid than R^{-5}, indicating local relaxation near the foreign ion. Above about 50 kbar there is a marked increase of trigonal distortion in Al_2O_3.

14590

LOW-TEMPERATURE DETERMINATION OF THE OSCILLATOR STRENGTH OF Cu_2O LINES OF THE GREEN SERIES.

J.B.Grun, M.Sieskind and S.Nikitine.
J. Phys. Radium (France), Vol. 22, No. 3, 176-8 (March, 1961).
In French.

The green series of absorption lines in Cu_2O crystals was studied by spectro-photometric methods at temperatures down to liquid helium. The oscillator strength, the maximum coefficient of absorption, and the width of the first lines (n = 2) of the green series were determined and compared with the corresponding results for the yellow series.

14591

REFLECTION AND ABSORPTION SPECTRA OF LiF IN THE EXTREME ULTRAVIOLET REGION.

R.Kato, K.Nakamura, A.Matsui and Y.Uchida.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2105-6 (Nov., 1960).

Observations were made between 800 and 1200 A. The reflection shows an excitation band peak at 980 A and a shoulder due to onset of the band-to-band transition at 900 A. A.G.Gaydon

14592

THE CRYSTAL SPECTRA OF VERY WEAK TRANSITIONS I. MEASUREMENTS OF THE NAPHTHALENE 3200 A SYSTEM AT 4°K.

D.P.Craig, L.E.Lyons and J.R.Walsh.
Molecular Phys. (GB), Vol. 4, No. 2, 97-112 (March, 1961).

The weak absorption system of crystalline naphthalene at 3200 A was measured at 4°K in polarized light. Previous work at 20°K is supplemented by a number of newly recorded absorption lines, and by re-measurement of the frequencies of all lines at the lower temperature. The spectrum is compared with the vapour spectrum and corresponding bands identified so far as possible. Exciton resonance effects are analysed and discussed. The analysis discloses that the important b_{3g} vibrations of upper state frequencies 438 and 911 cm^{-1} are both reduced by 5% in the crystal, and smaller changes are identified in other vibrations. Comparison with the vapour spectrum shows that vibrationally induced bands, even when relatively strong, are little influenced by intermolecular forces, whereas very weak pure electronic bands give evidence of much greater effects.

14593

THE CRYSTAL SPECTRA OF VERY WEAK TRANSITIONS II. THEORETICAL.

D.P.Craig and S.H.Walmsley.
Molecular Phys. (GB), Vol. 4, No. 2, 113-24 (March, 1961).

The theory of intermolecular resonance effects in the spectra of molecular crystals is extended to very weak systems in which the pure electronic transitions are either forbidden (as in the benzene 2600 A system) or comparable in intensity with accompanying vibrationally induced transitions (as in the naphthalene 3200 A system). For the pure electronic transitions the intermolecular coupling is through transition octupole moments, giving splittings and intensity transfers of the same type, though smaller, as those familiar in the stronger, dipole-coupled, systems. Values of octupole-octupole and octupole-dipole interactions sums are reported for naphthalene and the crystal spectrum calculated. For vibration-induced transitions it is shown that the intermolecular effects are due only to the small component of "stolen" character, thus allowing the lack of splitting and intensity transfer to be understood. The nature of such bands as arising from localized excitation can thus be explained in the framework of the simple rigid-lattice exciton theory.

14594

THE ULTRAVIOLET OH ABSORPTION BAND IN NaF.

E.Freytag.
Naturwissenschaften (Germany), Vol. 48, No. 8, 298 (1961).
In German.

OH ions in anion sites in NaF single crystals produce an absorption band with a maximum at 1500 A. Its position and width are scarcely altered by temperature change. A vibration frequency of OH also appears as absorption at 2.78 μ. F- and M-bands may be produced by irradiation at suitable wavelengths. S.T.Henderson

14595 ABSORPTION SPECTRA OF CRYSTALS OF SOME THIAZINE AND OXAZINE DYES. N.M.Melankholin.
Optika i Spektrosk. (USSR), Vol. 7, No. 4, 498-504 (Oct., 1959).
In Russian.

14596 COMMENT ON MELANKHOLIN'S ARTICLE ON ABSORPTION SPECTRA OF THIAZINE DYES.
J.R.Meyer-Arendt.
J. Opt. Soc. Amer., Vol. 51, No. 5, 583 (May, 1961).

14597 MODEL FOR THE ELECTRONIC STRUCTURE OF THE K AND L BANDS IN ALKALI HALIDES. A.Gold.
Phys. Rev. (USA), Vol. 123, No. 6, 1965-7 (Sept. 15, 1961).

A speculative model is proposed for the origin of the K and L optical absorption bands in alkali halide crystals. They are assigned to transitions of the F_2^+-centre (an anion vacancy pair plus an electron). This is plausible under the assumption that there is a plentiful supply of anion vacancies in the crystal. It is in general qualitative agreement with experiment. In addition, it possesses an advantage over ascribing these bands to transitions of the F-centre in that it explains the low quantum efficiency for photoconductivity observed in the L region.

14598 SPECTRUM OF CRYSTALLINE POTASSIUM FERROCYANIDE IN THE FAR INFRARED (45-140μ).
V.Lorenzelli and P.Delorme.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 92-4 (July 3, 1961).
In French.

14599 INFRARED SPECTRA OF URANYL PHOSPHATE, OXALATE, AND SALICYLATE IN THE SOLID STATE.
K.V.Narasimham.
Indian J. Phys., Vol. 34, No. 7, 321-30 (July, 1960).

The spectra were studied in the region 2-24μ using potassium bromide disk and nujol mull methods. About 35 bands in the phosphate, 25 in the oxalate and 40 in the salicylate were obtained from both methods. The vibrational frequencies obtained are correlated with those obtained from fluorescence experiments.

14600 INFRARED SPECTRUM OF SOLID CARBON MONOXIDE. G.E.Ewing and G.C.Pimentel.
J. chem. Phys. (USA), Vol. 35, No. 3, 925-30 (Sept., 1961).

The spectrum was examined at 20°K in the fundamental and overtone regions. Sharp features (bandwidths about one cm^{-1}) are assigned to vibrational modes of the various isotopic species: $C^{12}O^{16}$, 2138.1 cm^{-1}; $C^{12}O^{17}$, 2112.3 cm^{-1}; $C^{13}O^{16}$, 2092.2 cm^{-1}; and $C^{12}O^{18}$, 2088.4 cm^{-1}. These frequencies are examined with the aid of existing theories of frequency shifts in condensed phases. A broad absorption (bandwidth about 40 cm^{-1}) centred at 2208 cm^{-1} is assigned to combinations of the fundamental mode with lattice modes. Calculations suggest that the lattice modes involved probably include translations as well as librations.

14601 INFRARED SPECTRA OF CARBON MONOXIDE AS A SOLID AND IN SOLID MATRICES. A.G.Maki.
J. chem. Phys. (USA), Vol. 35, No. 3, 931-5 (Sept., 1961).

The fundamental infrared absorption frequency of several isotopes of CO was observed in solid carbon monoxide and in the solid matrices N_2, A, and CH_4. In addition, the overtone in solid carbon monoxide was measured. It is shown that frequency shifts due to isotopic substitution in the solid state follow the formulae developed for the gas phase only when molecules of the same isotopic species are not adjacent to each other, i.e. only in dilute solutions.

14602 STUDIES OF THE OPTICAL AND INFRARED ABSORPTION SPECTRA OF RUTILE SINGLE CRYSTALS.
B.H.Soffer.
J. chem. Phys. (USA), Vol. 35, No. 3, 940-5 (Sept., 1961).

The optical absorption of single crystals of synthetic rutile was investigated in the spectral range 1200 to 25 000 cm^{-1} from room temperature to 1000°C. The electronic absorption exhibits dichroic behaviour. The edge moves toward lower energies as temperature is increased, with the shift depending upon the absorption coefficient; for a decadic absorption coefficient α' of 400 cm^{-1}, the shift is -7.1×10^{-4} eV/deg K, while at 1 cm^{-1} it is -9.5×10^{-4} eV/deg K. The broad band in the region of 6850 cm^{-1} which occurs in reduced rutile does not appear in fully oxidized rutile, even at high temperatures. At high temperatures an additional wavelength-independent absorption appears which can be correlated in good agreement with d.c. conductivity by applying the Drude—Zener theory of free carrier absorption. New bands in the 3300 cm^{-1} region are shown to st
O—H valence vibrations. The main bands are unusually shar,
peaks at 3277 and 3322 cm^{-1} and half-widths of 28 and 13 cm
satellite structure of combination and difference bands was a
tected. Deuterium substitution produces an absorption band
2442 cm^{-1}. The entire structure shows a marked dependence
absorption on the polarization direction of the light. Some ev
is presented that these O—H groups cause a dielectric disper

14603 MOTIONS OF MOLECULES IN CONDENSED SYS
X. THE INFRARED SPECTRUM AND STRUCTU
A SINGLE CRYSTAL OF CYCLOPROPANE.
C.Brecher, E.Krikorian, J. Blanc and R.S.Halford.
J. chem. Phys. (USA), Vol. 35, No. 3, 1097-1108 (Sept., 1961)

The absorption of polarized infrared radiation by thin se
of single crystals of cyclopropane, grown in a specially desig
apparatus, was recorded in the frequency range between 700 a
5000 cm^{-1}, and compared with spectra, similarly recorded,
and vapour. The assignment of molecular modes is complete
The ν_5 fundamental, not previously measured, is located in th
crystal at 1078 cm^{-1}, while ν_4 and ν_{13} appear at 1133 and 119
respectively, confirming previously uncertain assignments.
frequencies of the primary lattice modes of the molecule in t
crystal are inferred from combinations. Site group and facto
splittings are seen to be of the same magnitude (≅ 10 cm^{-1}).
cyclopropane crystal is found to be orthorhombic (C_{2v} or D_{2h}
the molecules located at sites of C_s symmetry. An arrangem
of the molecules, described by space group P_{nm} (C_{2v}^7), whic
the most efficient packing, is proposed as the actual crystal
structure.

14604 MOTIONS OF MOLECULES IN CONDENSED SYS
XI. INFRARED SPECTRUM AND STRUCTURE O
SINGLE CRYSTAL OF ETHYLENE. C.Brecher and R.S.Half
J. chem. Phys. (USA), Vol. 35, No. 3, 1109-17 (Sept. 1961).

The infrared absorption spectra of thin sections of single
crystals of ethylene were recorded in the frequency range be
650 and 3600 cm^{-1}, using polarized infrared radiation. Comp
are made with similarly recorded spectra of the liquid and va
phases. A complete assignment of the absorption bands is gi
The frequencies of some primary lattice modes of the molecu
the crystal, and of some inactive molecular modes, are infer
from combinations. The ethylene crystal is found spectrosco
to be monoclinic (C_{2h}) or orthorhombic (D_{2h}), with the molecu
located at sites of C_i symmetry. Using the known lattice of th
carbon atoms, a molecular arrangement, described by space
$P\,2_1/n$ (C_{2h}^5), is derived as the true crystal structure.

14605 HIGH RESOLUTION STUDIES OF A VIBRATION—
ROTATION LINE IN SOLID HYDROGEN. H.P.Gu
J. Phys. Radium (France), Vol. 22, No. 3, 149-53 (March, 196
In French.

Intermolecular forces give rise to an infrared absorption
spectrum in solid hydrogen. The rotation—vibration line $S_1(0$
studied at high resolution in crystals of pure para-hydrogen a
those containing small quantities of ortho-hydrogen. Quadrup
coupling between an excited para molecule and a neighbouring
molecule is responsible for a splitting of the line.

14606 INFRARED ABSORPTION OF ELECTRONS THRO
PIEZOELECTRIC SCATTERING. T.Tanaka.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2110-11 (Nov., 1960).

Summarizes a calculation of the cross-section for absor
of an infrared photon by conduction electrons, due to piezoele
scattering by acoustic vibrations, in ionic crystals with wurtz
structure. See also following abstract. J.H

14607 INFRARED ABSORPTION OF FREE CARRIERS I
IONIC CRYSTALS. T.Tanaka.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2121 (Nov., 1960).

See also preceding abstract. The cross-section due to
interactions of electrons with the longitudinal optical vibratio
calculated; a numerical estimate for ZnO is reasonably near
experimental value. J.H

14608 DICHROISM AND INTERPRETATION OF THE INF
RED BANDS OF ORIENTED CRYSTALLINE POLY
ETHYLENE. J.R.Nielsen and R.F.Holland.
J. molecular Spectrosc. (USA), Vol. 6, No. 4, 394-418 (April,

The infrared absorption spectrum of oriented, highly crys

ex 50 polyethylene was studied with linearly polarized radiation.
the dichroism data as criteria, a rather complete interpretation
ven of the spectrum.

4609 ABSORPTION SPECTRA OF Cu^{2+} IN DIFFERENT CRYSTAL COORDINATIONS. R.Pappalardo.

olecular Spectrosc. (USA), Vol. 6, No. 6, 554-71 (June, 1961).
The absorption spectra of Cu^{2+} in two oxide systems, ZnO and
um gallium garnet, are reported and compared with the pre-
ons of the crystal field theory. The site symmetry at the Cu^{2+}
ttrium gallium garnet can be inferred from the absorption
tra.

610 VIBRATIONAL SPECTRA OF SILICATES. II. THE INFRARED ABSORPTION SPECTRA OF SILICATES AND MANATES WITH CHAIN ANIONS.

Lazarev and T.F.Tenisheva.
a i Spektrosk. (USSR), Vol. 10, No. 1, 79-85 (Jan., 1961).
ssian.
For Pt I, see Abstr. 2327 of 1961. Reports and interprets the
rption spectra of metasilicates and metagermanates containing
r two XO_4 tetrahedra in their chains. The compounds studied
Cu_2GeO_3, Na_2GeO_3, Li_2GeO_3, Li_2SiO_3, Na_2SiO_3, $NaFe^{3+}Si_2O_6$,
$^{2+}Si_2O_6$, $CaMgSi_2O_6$, $(Mg, Fe)_2Si_2O_6$ and $NaAlSi_2O_6$. [English
slation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 37-40
., 1961)]. A.Tybulewicz

4611 LOW-LYING SPECTRUM OF RARE-EARTH IRON GARNETS. M.Tinkham.

s. Rev. (USA), Vol. 124, No. 2, 311-20 (Oct. 15, 1961).
The spin-wave spectra of simplified two- and three-sublattice
of the rare-earth iron garnets are obtained, and shown to
ain an iron spin-wave spectrum similar to that in yttrium iron
et, together with one and two optical branches, respectively.
nsities for optical excitation of k = 0 spin waves are computed,
the effect of an external magnetic field on the resonant
uencies is also found. The consequences of anisotropic
lues, which can be very different from the Landé g_J, are
ored. Whereas frequencies are determined by the g-values
g the exchange field produced by the iron, selection rules
nd on transverse g-values. This results in absorption at
le-ion splitting frequencies as well as at the Kaplan—Kittel
ange resonance frequency $\omega_e = \lambda(\gamma_2 M_1 - \gamma_1 M_2)$. The aniso-
y in the g-values also produces a shift in the exchange
nance frequency, which can be related to the macroscopic
otropy energy deduced from the anisotropic single-ion exchange
ttings. Agreement with experimental data on ytterbium iron
et (see following abstract) is excellent. Application of the
ry to anisotropy effects in ferrimagnetic resonance of rare-
h-doped yttrium iron garnet is also considered. Finally, the
ific heat capacity is considered and shown to be well approxi-
ed by the single-ion Shottky anomaly approximation used by
er and Harris.

4612 FAR-INFARED EXCHANGE RESONANCE IN YTTERBIUM IRON GARNET.

Sievers, III and M.Tinkham.
s. Rev. (USA), Vol. 124, No. 2321-5 (Oct. 15, 1961).
See preceding abstract. An exchange resonance was observed
pressed powder sample of YbFe garnet at 14.1 ± 0.2 cm^{-1} at
. The temperature dependences of the resonance frequency and
rption strength were measured from 2^0 to 66^0K. The resonant
uency at all temperatures is in good agreement with the two-
attice theory when the appropriate spectroscopic g-value ($3g_J$)
sed and when the anisotropy energy is taken into account at low
peratures. The two-sublattice model also reproduces the
sured absorption strength to within a factor of two, and its
perature dependence even more precisely. Two other magnetic
rptions with temperature-independent frequencies were
erved at 23.4 ± 0.3 and 26.4 ± 0.3 cm^{-1}. At 30^0K, an 11 kOe
on a single crystal was found to vary the frequency and inten-
of these lines, which arise from the exchange splittings of the
rbium ground-state doublet. The contribution via dispersion
ry of the infrared absorption lines to the static susceptibility
^{0}K is in good accord with the d.c. value measured by Pauthenet
str. 11221 of 1959). This agreement suggests that all major
ributions to the static susceptibility were measured.

14613 THE FORM OF THE RAMAN SCATTERING TENSOR. L.N.Ovander.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 571-5 (Nov., 1960).
In Russian.

Group-theory methods are used to obtain the Raman scattering tensor for all vibrations of a crystal belonging to any of the 32 crystal classes. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 302-4 (Nov., 1960)]. A.Tybulewicz

14614 RAMAN SCATTERING OF LIGHT IN SUPER-CONDUCTORS. A.A.Abrikosov and L.A.Fal'kovskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 262-70 (Jan., 1961).
In Russian.

A computation is carried out of Raman scattering upon reflection of light from the surface of a superconductor. The distribution with angle and frequency of the scattered light and the absolute magnitude of the effect are found. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 179-84 (July, 1961)].

14615 PRECISION MEASUREMENT OF L X-RAY WAVE-LENGTHS AND LINE WIDTHS FOR $74 \leq Z \leq 95$ AND THEIR INTERPRETATION IN TERMS OF NUCLEAR PERTURB-ATIONS. J.J.Merrill and J.W.M.DuMond.

Ann. Phys. (USA), Vol. 14, No. 1, 166-228 (July, 1961).

Techniques for the precision measurement of X-ray lines using the two-crystal spectrometer are discussed, and then applied to measurement of the L X-ray spectra of the transuranic elements uranium, neptunium, plutonium, and americium. In all, 52 emission lines and 4 L_{III} absorption edges were measured, all of them with higher precision than has heretofore been obtained and many of them for the first time. Using these data, the binding energies of the electrons for these atoms were computed. The L_{II}—L_{III} level splitting was computed and compared with theory and it was found that current theory is not sufficient to account quantitatively for the observed data. Certain features of the emission line widths are discussed and given qualitative explanations in terms of the Coster—Kronig transition L_{II}—$L_{III}M_V$ and hyperfine structure. The observed hyperfine structure is due to the large magnetic moment of Np^{237} which leads to increased widths of certain of the Np lines. It is believed that this is the first experimental observation of hyperfine structure in X-ray spectra.

14616 INVESTIGATION OF THE K—ABSORPTION SPECTRUM OF SMALL ZINC ADDITIONS IN ALUMINIUM-ZINC ALLOYS. S.A.Nemnonov, M.F.Sorokina and L.D.Finkel'shtein.

Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 1, 148-150 (July, 1960). In Russian.

A comparative study was made of the K—absorption edges of pure Zn, pure Al, Zn in 0.7 at.% Zn—Al, and Al in the same alloy. It is inferred that both components of the alloy studied have a common conduction zone, almost identical with that of pure Al. M.H.Sloboda

14617 X-RAY ABSORPTION SPECTRA OF COMPOUNDS WITH THE NICKEL ARSENIDE STRUCTURE.

A.Z.Men'shikov and S.A.Nemnonov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 390-5 (Sept., 1960). In Russian.

Study of the K-absorption edges of Cr, Cr_2O_3, $CrS_{1.17}$, CrSe, CrTe, and CrB confirmed Pearson's hypothesis (Abstr. 9692 of 1957) that the d-electrons of the transition metals play only an insignificant part in the formation of the chemical bond in NiAs-type structures. The results indicate that the compounds studied are most likely characterized by the p^3- and sp^2-electron configuration. Although the covalent bond appears to predominate in chalcogenides of transition metals, the bonds in structures of this type appear to be unsaturated — which points to a complex, covalent-metallic nature of the atomic interaction. M.H.Sloboda

14618 SOFT X-RAY EMISSION SPECTRUM OF NIOBIUM. J.E.Holliday.

Phil. Mag. (GB), Vol. 6, 801-4 (June, 1961).

The soft X-ray M-emission spectrum of Nb was measured. The $M_{iv,v}Y_{ii}$ peak was found to be the $M_{iv,v}$ emission band and the $M_{iv,v}Y_i$ peak is a satellite of the $M_{iv,v}N_{ii,iii}$ emission line. The emission spectrum indicates that Nb is similar to vanadium in that the 4d-electrons are not localized and are in the conduction band. In addition, the soft X-ray spectrum indicates that some of the electrons in the band have p-character.

14619 EFFECTIVE DEPTH OF X-RAY PRODUCTION.

H.P.Hanson and S.I.Salem.

Phys. Rev. (USA), Vol. 124, No. 1, 16-21 (Oct. 1, 1961).

By measuring X-ray emission profiles as a function of voltage, the depth of penetration of the cathode electrons involved may be calculated. Similarly, the effective depth of X-ray production may be obtained. Uncertainties exist because of conditions at the surface, so the rate of change of these depths with voltage may be established with greater confidence than the values themselves. For copper, the continuum yields values increasing from 300 to 480 A/kV over the 10-30 kV range. An average value of 450 A/kV is obtained from analysis of the less trustworthy line data. The effective depth obtained from the conventional calculation on the absorption edge is shown to have little physical meaning.

14620 INDIRECTLY AND DIRECTLY PRODUCED X-RAY LINE RADIATION.

H.P.Hanson and D.J.Cowan.

Phys. Rev. (USA), Vol. 124, No. 1, 22-6 (Oct. 1, 1961).

A direct comparison was made of the number of X-ray quanta in the K line spectrum to the number of quanta in the continuous spectrum having energies greater than the critical value for K excitation. From this, one can deduce that, for a copper target operating at low voltages, only about 10% of the line radiation is indirectly produced. A further result is that the ratio of the cross-section for direct ionization to the cross-section for bremsstrahlung production is about 4/1, a value which is at least an order of magnitude less than theory predicts.

14621 STUDY OF THE CHARACTERISTIC ABSORPTION OF X-RAYS IN Ti COMPOUNDS [Ti, TiO$_2$, TiN, TiC, TiH].

S.M.Karal'nik, L.H.Nikolayeva and Yu.I.Korolenko.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 404-5 (1959). In Ukrainian.

14622 INVESTIGATION OF THE CHARACTERISTIC X-RAY ABSORPTION OF TRANSITION METAL SILICIDES.

V.S.Neshpov, L.H.Nikolayeva and S.M.Karal'nik.

Ukrayin.fiz. Zh. (USSR), Vol. 4, No. 6, 814-15 (1959). In Ukrainian.

14623 ON THE DETERMINATION OF PLANCK'S CONSTANT FROM THE SHORT-WAVELENGTH LIMIT OF THE X-RAY SPECTRUM.

K.Ulmer.

Z. Phys. (Germany), Vol. 162, No. 3, 254-74 (1961). In German.

A detailed study of the spectral intensity curve of solids in the neighbourhood of the short wavelength limit of the X-ray bremsstrahlung spectrum is presented, and applied to measurements on tungsten. The analysis given removes existing discrepancies in the determination of Planck's constant between bremsstrahlung methods and other methods. For a short note with preliminary results of this work see Abstr. 2094 of 1960. P.M.Parker

14624 LIGHT SCATTERING BY ANISOTROPIC INHOMOGENEITIES IN THIN POLYMER FILMS UNDER STRAIN. II.

L.Bhatnagar.

J. chem. Phys. (USA), Vol. 35, No. 3, 999-1002 (Sept., 1961).

For Pt. I, see Abstr. 6374 of 1960. Scattering by anisotropic inhomogeneities embedded in thin polymer films under two- and three-dimensional strain is treated theoretically. To take into account the effect of polydispersity, the differential cross-sections for scattering are obtained for an assumed Maxwellian distribution in size at constant value of p, the ratio of the minor to major axis of an inhomogeneity.

Luminescence

14625 LUMINESCENCE OF IMPURITY CENTRES. III.

A.M.Ratner and G.E.Zil'berman.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 687-97 (March, 1961). In Russian.

For Pts I-II, see Abstr. 11768-9 of 1960. The absorption and luminescence band structure is calculated with a quantum-mechanical treatment of the ionic motion, taking into account the change of the elastic constants on electronic transitions. The connection between the elastic constants of the lattice distorted by impurity atoms, and the parameters of the luminescence and absorption band structure is established in the classical case. It is shown that in the case of strong interactions the classical theory contains only a small
number of parameters which are determined by the interacti
an impurity atom with its nearest neighbours. At temperatu
above one fifth of the Debye temperature of the crystal the i
action of the impurity atom with nearest neighbours can agai
expressed in terms of the elastic constants, as in the classic
At lower temperatures the expression for the form of the ab
and luminescence spectra contains also the dispersion law f
normal oscillations of the ideal lattice. [English translation
Soviet Physics—Solid State (USA), Vol. 3, No. 3, 499-506
(Sept., 1961)]. K.

14626 LUMINESCENCE OF IMPURITY CENTRES. IV.

A.M.Ratner.

Fiz.tverdogo Tela (USSR), Vol. 3, No. 3, 704-12 (March, 196
In Russian.

A particular case of the theory outlined in Pt III is cons
in a number of cases of crystals of the rock salt type when t
theoretical parameters are expressed in an obvious form in
of the lattice constants. The probability of thermal transitio
calculated, taking into account the change in the elastic cons
on electron transitions. The motion of the ions is treated qu
mechanically. As in the classical case, deviation from the l
mirror symmetry (connected with the change in elastic cons
essentially affects the thermal transition probability. [Engli
translation in: Soviet Physics—Solid State (USA), Vol. 3, No.
513-19 (Sept., 1961)]. K.

14627 THE INTERACTION OF AN ACTIVATOR WITH PARTLY SYMMETRICAL LOCAL VIBRATIONS.

N.N.Kristofel'.

Optika i Spektrosk. (USSR), Vol. 9, No. 5, 615-20 (Nov., 1960
In Russian.

Discusses the interaction of an activator with partly sym
rical local vibrations (Jahn—Teller effect) in the case of the
state of a luminescence centre in KCl:Tl and deals with som
related problems. [English translation in: Optics and Spect
(USA), Vol. 9, No. 5, 324-6 (Nov., 1960)]. A.Tyb

FLUORESCENCE OF CaF$_2$ MONOCRYSTALS. See Abs

14628 ON THE FLUORESCENCE OF Sb- AND Mn-ACT CALCIUM HALOPHOSPHATES.

E.Ostaszewicz.

Acta phys. Polon. (Poland), Vol. 19, No. 4, 421-42 (1960).

Sb- and Mn-activated calcium halophosphates were prod
and their fluorescence was investigated by the spectral meth
dependence on the activator concentration and the weight rat
the halogens. The trichromatic colour coordinates were co
from the experimental intensity distribution. A maximum of
quantum yield of the fluorescence as a function of the activat
and halogen concentration and a displacement of the fluoresc
maximum of Mn were found at 5760-5935 A when fluorine ha
been entirely replaced by chlorine. The fluorescence mecha
is discussed in detail; direct resonance energy transfer fro
sensitizer to the activator was found to agree best with the
experimental results. The range of the Sb-to-Mn energy tra
amounts to 50 cation spacings. Perturbation theory as applie
resonance transfer of energy in solids yielded an explanation
possibility of Mn transitions into forbidden states through th
agency of the sensitizer, the return wherefrom giving rise t
orange fluorescence characteristic of Mn.

14629 INFRARED LUMINESCENCE OF A SURFACE L OF Cu$_2$O.

Yu.V.Vorob'ev and Yu.I.Karkhanin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 206-11 (Jan., 1961)
In Russian.

The apparatus used is illustrated and described in detail
passing through a system of filters (including interference fi
the light from an incandescent bulb passed from below throu
glass plate, a translucent Pt film, and an electrolyte, and fel
Cu$_2$O specimen whose infrared radiation was measured with
multiplier. Various potentials, not exceeding 5 V, were appli
ween Pt and Cu$_2$O; the electrolytes used were Na$_2$CO$_3$ and Na
When Cu$_2$O was chosen as the cathode, the intensity of lumin
dropped, while no changes could be observed in the cell; the
of intensity was reversible (and momentary for potentials ≤
For potentials between 2.5 and 8 V the initial change was ins
aneous, but was followed by a period of slow change. It is co
that the edges of energy bands at the semiconductor surface
shifted towards the barrier virtually by the applied potential.

rs show that the effect of an external potential on the extinction ,O luminescence in solutions of electrolytes can be explained tatively and quantitatively) by the shift referred to above. ish translation in: Soviet Physics—Solid State (USA), Vol. 3, , 150-3 (July, 1961)]. F.Lachman

630 LUMINESCENCE OF CHROMIUM (III) COMPLEXES.
L.S.Forster and K.De Armond.

em. Phys. (USA), Vol. 34, No. 6, 2193-4 (June, 1961).

Chelates of Cr^{3+} with acetylacetone (a.c.a.) and with iroxyquinoline, in dilute glassy solutions at -183°C, were ed by wavelengths 3660, 4358 or 5460A to give an emission band a peak at 13200 cm^{-1}. For $Cr(a.c.a.)_3$ the absorption band has ximum near 19000 cm^{-1} and a minimum near 21000 cm^{-1}. The n of the luminescence is discussed with reference to these and Cr complexes, and theprobable transition is considered to be A_2. S.T.Henderson

631 ANALYSIS OF P—N LUMINESCENCE IN Zn-DOPED GaP.
H.G.Grimmeiss and H.Koelmans.

. Rev. (USA), Vol. 123, No. 6, 1939-47 (Sept. 15, 1961).

The p—n luminescence and photoluminescence of Zn-doped were investigated. Spectral distributions and the light output function of temperature and excitation density were recorded. light output of the p—n luminescence shows a strongly super-r dependence on excitation density. With rising temperature, uperlinear range shifts to higher excitation densities. Using a e-level model the recombination kinetics are analysed with the f the Klasens code-number method. The analysis given allows terpretation of the superlinearity and gives a quantitative ination of the observed shift of the superlinear range with erature.

4632 THE LUMINESCENT PROPERTIES OF LITHIUM FLUORIDE ACTIVATED BY URANIUM.
.Belyaev, Z.B.Perekalina, V.N.Varfolomeeva, V.P.Panova and Dobrzhanskii.

tallografiya (USSR), Vol. 5, No. 5, 757-60 (Sept.-Oct., 1960). ıssian.

A study has been made of the luminescence (450-600 mμ) and rption (230-450 mμ) spectra of single crystals grown by the ɔpoulos method in an open crucible with different activator entrations. In the activator concentration range from 0.01 to %, an effect of the redistribution of the intensity among the s was discovered in the luminescence spectrum. At the same , the absorption spectrum is shifted into the longer-wave on. It is shown that luminescence may be used for studying the th processes of impurity crystals. [English translation in: et Physics—Crystallography (USA), Vol. 5, No. 5, 722-5 ch-April, 1961)].

4633 THE NATURE OF STIMULATED LUMINESCENCE IN KCl CRYSTALS.
N.P.Kalabukhov.

Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 2, 229-31; Disc. 242-5 0). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of). Optically and thermally stimulated luminescence of ay-coloured KCl crystals is discussed in terms of formation dissociation of M-centres, each consisting of an F-centre ciated with two vacancies. A.Tybulewicz

4634 LUMINESCENCE DECAY IN AgCl CRYSTALS.
K.Vacek.

h. J. Phys., Vol. 10, No. 8, 468-74 (1960).

The kinetics of luminescence decay of single crystal plates of l was measured at the temperature of liquid nitrogen. Lumine-ce decay first takes place (for $t \leq 2.5 \times 10^{-3}$ sec) according to perbola and then according to an exponential. The constants d a of the hyperbolic and τ of the exponential dependence were sured for different intensity of the exciting radiation in normal deformed samples and in samples irradiated with β-particles ng measurement.

4635 LUMINESCENCE OF DOPED SILVER CHLORIDE CRYSTALS.
S.Sonoike and K.Akimoto.

hys. Soc. Japan, Vol. 16, No. 4, 658-64 (April, 1961).

Luminescences of AgCl crystals doped with $CdCl_2$ and $FeCl_3$ e measured spectroscopically at low temperatures. Effects of liary infrared light on them and on photoconductivity were measured. Cd ions change the normal maximum luminescence gCl at about 485 mμ to a longer wavelength of 545 mμ at low temperatures. When the latter luminescence is thermally quenched, the usual maximum of 485 mμ recovers and then it is also thermally quenched. The infrared light enhances the luminescence of 545 mμ and quenched that of 485 mμ. This quenching is drastic when Fe ions are added. The photoconductivity is enhanced by the infrared light in Cd doped crystals and is almost not quenched in Fe doped crystals. An energy band model is given to explain the experimental results.

14636 A PARAMAGNETIC-RESONANCE STUDY OF THE EFFECT OF A FLUX ON THE STATE OF AN ACTIVATOR IN A PHOSPHOR.
V.G.Dubinin.

Optika i Spektrosk. (USSR), Vol. 9, No. 4, 531-3 (Oct., 1960). In Russian.

Describes a study of SrS:Eu:Sm phosphors prepared with and without a flux (LiF or $SrCl_2$). The concentration of Eu^{2+} was 30-40% greater in the phosphors with a flux than in the phosphors without a flux, although the amount of Eu introduced initially was the same in all phosphors. Assuming that Eu is non-volatile, it was found that the phosphors with a flux contained 90-100% Eu in the Eu^{2+} state. The phosphors without a flux had only 60% Eu in the Eu^{2+} state; it was not clear what was the state of the remaining 40% Eu. The fluxes also affected the phosphorescence spectra, luminescence during excitation, and the light sums emitted on de-excitation. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 279-80 (Oct., 1960)]. A.Tybulewicz

14637 FLUORESCENCE SPECTRA OF SOLUTIONS OF URANYL NITRATE AT LIQUID AIR TEMPERATURE. I. RAPIDLY COOLED SOLUTIONS.
D.D.Pant and D.P.Khandelwal.

Proc. Indian Acad. Sci. A, Vol. 51, No. 2, 60-74 (Feb., 1960).

Photometric studies on the fluorescence spectra of rapidly cooled aqueous and alcoholic solutions of uranyl nitrate are reported. Five distinct series of bands, designated as α, β', γ, δ and α' appear, depending upon concentration, pH, solvent, etc. From their conditions of enhancement and suppression and close analogy with corresponding room temperature spectra, the α and γ-bands are shown to be due to the species UO_2^{2+} (hydrated) and $UO_3UO_2^{2+}$. Higher hydrolysed species give δ-bands. The α'-bands, which appear in alcoholic solutions also, are attributed to $UO_2(NO_3)_2.xH_2O$. The assignment of β'-bands is not certain. The intensity distribution in various series is studied and it is found that relative to α series the distribution is largely shifted away from the (0,0) band in α' series and towards the (0,0) band in γ series. The α' and γ-bands disappear around -60° C, which corresponds to the transformation temperature of ice structure. Various characteristics in the spectra are discussed on the basis of environmental differences in the species.

14638 FLUORESCENCE SPECTRA OF SOME URANYL SALTS.
K.V.Narasimham.

Indian J. Phys., Vol. 35, No. 6, 282-98 (June, 1961).

The fluorescence spectra of uranyl acetate, nitrate, sulphate, fluoride I, chloride, potassium uranyl sulphate and ammonium uranyl sulphate were reinvestigated at room and liquid air temperatures and new analyses are proposed for each spectrum on the basis of a single electronic allowed transition.

14639 FLUORESCENCE, PHOSPHORESCENCE AND "REDUCTION" OF A SAMPLE OF WILLEMITE ACTIVATED WITH MANGANESE.
H.A.Arduino, J.C.Guerci, A.Levialdi and N.Majlis.

J. Phys. Radium (France), Vol. 22, No. 4, 220-4 (April, 1961). In French.

This paper introduces a course of research on the measurement of the absolute efficiency with an absolute differential radiometer. The use of an oscillograph phosphoroscope makes possible the photography of the excitation and decay curves between 15°C and 200°C of a willemite sample ($ZnSiO_4$ with 1% Mn). By means of an enlarged negative, the total light was measured and compared with the total extinction light. The analysis of these curves allows the definition of two different fluorescent mean lifetimes and one phosphorescent one. The so-called "reduction" (relative variation of efficiency with temperature) was measured, corresponding to a variation with temperature of the internal energy transfer.

14640 AGEING OF ZnS PHOSPHORS.
I.K.Vereshchagin.

Optika i Spektrosk. (USSR), Vol. 9, No. 4, 519-21 (Oct., 1960). In Russian.

The electroluminescence and photoluminescence spectra of ZnS and ZnS—CdS phosphors, containing silver and large amounts of copper, were compared immediately after preparation and after 1-3 years' storage. The short-wavelength band in photoluminescence (characteristic of non-activated and Ag-activated phosphors) was intensified by storage. The band due to copper was either weakened or remained unaffected by storage. The photoluminescence spectrum of stored phosphors approached the form of the electroluminescence spectrum. The effects of long storage could be removed entirely by heating above 200° C for 20-30 min. The changes on ageing were due to changes in the amount of free sulphur in the phosphors: CuS or Ag_2S formed slowly in the phosphors at room temperature. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 270-1 (Oct., 1960)]. A.Tybulewicz

14641 EFFECT OF INFRARED IRRADIATION ON ZnS:Cu PHOSPHORS. H.Kallmann and K.Luchner.

Phys. Rev. (USA), Vol. 123, No. 6, 2013-19 (Sept. 15, 1961).

Infrared stimulation and quenching of luminescence of ZnS:Cu phosphors are studied as a function of trap population. It is found that stimulation at low temperature increases linearly with the concentration of ionized activators and disappears when the shallowest traps are emptied. Quenching increases as the product of the concentrations of ionized activators and trapped electrons. From these results it is concluded that the main action of infrared on these phosphors is a shifting of holes to levels of higher recombination rate. This model accounts quantitatively for the dependence of stimulation and quenching on the state of excitation. It is strongly supported by infrared effects on the glow and photoconductivity and the similarity of the wavelength dependence of stimulation and quenching. Thus the light stimulation observed under infrared irradiation is not due to the usual assumption of a direct release of trapped electrons by infrared, but rather to a shifting of holes to levels of higher recombination rate.

14642 PARAMAGNETIC RESONANCE DETECTION OF LUMINESCENT CENTERS AND TRAPS IN SELF-ACTIVATED ZnS PHOSPHORS. P.H.Kasai and Y.Otomo.

Phys. Rev. Letters (USA), Vol. 7, No. 1, 17-18 (July 1, 1961).

Polycrystalline, self activated, ZnS phosphors showed two additional peaks at liquid nitrogen temperatures when illuminated with u.v. The peak is broadened when the flux anion is changed from Cl^- to Br^- and the g value is anisotropic. Co^{2+} ions enhance one of the peaks and depress the other. A Zn^{2+} ion vacancy surrounded by three S^{2-} ions and one halide ion, a defect proposed by Prener and Williams (Abstr. 3636 of 1956), could account for these results. J.E.Caffyn

14643 THE MECHANISM OF TRANSITIONS OF EXCITED ORGANIC MOLECULES INTO METASTABLE STATES.

G.A.Mokeeva and B.Ya.Sveshnikov.

Optika i Spektrosk. (USSR), Vol. 10, No. 1, 86-90 (Jan., 1961). In Russian.

Reports a study of the effect of temperature on the duration of fluorescence and phosphorescence and on the relative phosphorescence yield of boron—glycerin phosphors activated with fluorescein (1), glacial sugar phosphors activated with trypaflavine (2), acridine orange (3), and esculine (4), as well as boron phosphors activated with phthalimide (5). In the first three phosphors increase of temperature raised the phosphorescence yield and reduced the duration of fluorescence. Both these effects were explained by the dependence of the probability of transitions of excited molecules into metastable states on the vibrational energy of the molecules. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 1, 41-3 (Jan., 1961)]. A.Tybulewicz

14644 ABSORPTION AND LUMINESCENCE ORIGINS IN ANTHRACENE CRYSTALS.

P.W.Alexander, A.R.Lacey and L.E.Lyons.

J. chem. Phys. (USA), Vol. 34, No. 6, 2200-1 (June, 1961).

Observations of the absorption and luminescence spectra at 4°K of zone-refined anthracene crystals and of crystals of various purities have shown that the large difference once supposed to exist between fluorescence and absorption origins in anthracene crystals is not a property of the pure crystal. The purest anthracene showed no absorption between 24 800-25 030 cm^{-1}, but less pure material showed bands in this region due to impurities (e.g., anthraquinone). Free exciton luminescence from pure anthracene crystals is expected to originate at 25 150 cm^{-1} (b polarized). A luminescence origin at 25 040 cm^{-1} was observed in the purest crystal (compared with 24 840 cm^{-1} in an impure crystal), the slight difference from the expected value being attributed to reabsorption. J.B.Birks

14645 THE CONCENTRATION QUENCHING OF THE FLUORESCENCE OF ANTHRACENE IN PLEXIGL

A.Kawski and Z.Polacki.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 11-12, 817-19 (1960). In German.

Jablonski's theory of depolarization in solid solutions doe
not agree with earlier experimental results for concentrated
solutions in Plexiglas (Perspex), possibly because the theory
neglects concentration quenching. New experiments show that
quenching begins at 10^{-2} mole/litre, when the mean radius of
sphere of action of the molecule is 45 A. S.T.Hen

14646 ACCOUNTING FOR THE REABSORPTION OF IMPURITY LUMINESCENCE IN NAPHTHALENE—ANTHRACENE CRYSTALS. V.N.Vÿshnevs'kÿi.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 313-23 (1958). In Ukr

Th profile of the shortest wave-band in the luminescence
spectrum of the anthracene impurity is established for all ant
impurity concentrations lying within the range of the solubility
the latter in naphthalene. This makes it possible to correct
previous values [ibid., Vol. 1, 294 (1956)] for the quantum outp
the anthracene components of the luminescence. It is shown t
because of the overlapping and absorption of luminescence sp
about 15—20% of the initial energy emitted by the anthracene
impurity molecules is reabsorbed. Introducing this correctio
the values of the absolute quantum output of the impurity lumi
escence, it is possible to improve the accuracy of the earlier
sal of a number of parameters characterizing the phenomenon
excitation-energy migration in molecular crystals.

14647 THE EFFECT OF VITRIFICATION ON POLARIZA OF LONG-LIVED LUMINESCENCE OF ORGANIC SUBSTANCES. E.V.Anufrieva.

Optika i Spektrosk. (USSR), Vol. 9, No. 4, 547-8 (Oct., 1960). In Russian.

Polarization of long-lived luminescence during its decay
measured in two systems: polyvinyl alcohol with 0.1% rhoduli
orange, and glucose with 0.1% rhoduline orange, between 20° a
120° C, i.e. both above and below the vitrification temperature
of the two systems. The polarization was independent of time
all temperatures below T_g of the particular system. Above T
polarization fell with time during decay of luminescence; the
amount of fall increased with increase of temperature. If the
depolarization during decay above T_g was due to Brownian mo
of molecules, the constancy of the polarization in vitreous sta
indicated freezing of the motion of the luminescing molecule a
macromolecules surrounding it. Increase of the mobility of m
molecules on softening above T_g caused the observed fall of th
polarization. [English translation in: Optics and Spectrosc. (
Vol. 9, No. 4, 290-1 (Oct., 1960)]. A.Tybu

14648 ABSORPTION AND LUMINESCENCE OF IMPURIT IN ORGANIC COMPOUND CRYSTALS AT 20°K.

III. NAPHTHACENE SPECTRA IN CRYSTALS OF CERTAIN POLYPHENYLS. A.V.Soloviov.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 615-28 (1959). In Ukr

For Pt I and II, see Abstr. 11374-5 of 1961. Electronic
absorption and luminescence spectra were obtained for napht
impurities in para-terphenyl and para-quaterphenyl crystals.
comparison was made of electron-oscillatory frequencies in s
of naphthacene dissolved in a number of organic crystals. Th
author discusses the question as to whether these frequencies
solvents are affected due to the changes set up in the electron
of the impurity molecule. It is shown that a slight deformatio
naphthacene molecule skeleton by the surrounding solvent cry
molecules is sufficient to explain the observed changes in the
electron-oscillatory frequencies. It is noted that the greater
shift of the impurity spectrum toward the long-waves region,
compared with the spectrum of its vapours, the more indistin
bands in the impurity spectrum.

14649 INFLUENCE OF THE DEGREE OF POLYMERIZA ON THE LUMINESCENCE YIELD AND ENERGY TRANSPORT IN SYNTHETIC SCINTILLATORS. H.Heusinge

Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1068-72 (Dec.,
In German.

Films of polystyrene and polyvinyl acetate about 0.3 mm
containing terphenyl or other organic phosphors, and with so
residual solvent, were excited by Sr^{90}. The light output incre

dily with the degree of polymerization (between 10^2 and 10^4) vided that the phosphor was present in a quantity smaller than mole to one mole of polymer. An excess of the phosphor caused pid decrease of the yield. Efficiency was altered by different ents, aromatics being favourable. Some ultraviolet excitation eriments are described, and the scintillation mechanism is fly discussed. S.T.Henderson

4650 ON THE DECAY PROCESSES OF POLARIZED PHOTOLUMINESCENCE.

A.Jablonski.

Vaturforsch. (Germany), Vol. 16a, No. 1, 1-4 (Jan., 1961). ierman.

Previous experiments showed that the luminescence decay of different components of polarized emission was not exponential. pecific form of time dependence of depolarization processes was used but only furnished qualitative explanation of the observed ays. The effect of torsional oscillations of the emitting centres iscussed since this introduces anisotropic behaviour. A specific erimental case due to Kessel is examined with reference to such illations assuming their biggest effect to occur for low viscosity itions. G.F.J.Garlick

4651 GROUP TRANSITIONS IN SOLID LUMINOPHORS.

T.I.Kakushadze.

Phys. (Germany), Vol. 8, No. 1-2, 111-15 (1961).

As a result of the strong interaction of electrons with the ice, the transition of the electrons from the ground band to the duction band of the semiconductor involves a large number of trons. In this process the energy necessary for the intershell nsition is compensated by re-arrangement of the other electrons he group. Therefore the electron group transitions always occur energetically and consequently non-radiatively. Nearly all plex processes known at present to occur in solid phosphors be explained in the light of a group transition of this kind.

4652 DIFFUSION EFFECTS IN ELECTRON BOMBARDMENT INDUCED PROCESSES. I. CATHODOLUMINE- NCE.

G.Gergely.

a phys. Hungar., Vol. 12, No. 3, 221-40 (1960).

An analysis of the voltage dependence of processes induced by tron bombardment is given taking into consideration the face recombination and diffusion. The diffusion equation of ore is combined with Koller—Alden's, Young's and dman's laws relating to the dissipation of beam power and etration of incident electrons. The cathodoluminescence is lysed on the basis of the Schön—Klasens model. For 5 kV × 1 μA cm^{-2} excitation density the luminescence processes be characterized by code number 122122 of Klasens in ZnS sphors. The diffusion of minority carriers may be described linear differential equation. Good agreement was obtained veen the theoretical and experimental brightness versus age curves. By their analysis the diffusion length L and the ocity S of the surface recombination was determined. It was d that $L = 0.05\text{-}0.2$ micron and $S = 6 \times 10^3\text{-}10^6$ $cmsec^{-1}$ for eral phosphors. The lifetime and mobility of holes was mated in ZnS, $\tau_p = 4.4 \cdot 10^{-10}$ sec, $\mu_p = 11$ $cm^2/Vsec$.

4653 EFFECT OF ELECTRON BOMBARDMENT ON THE NEAR-INFRARED FLURORESCENCE OF SINGLE- STAL CdS.

B.A.Kulp.

ppl. Phys. (USA), Vol. 32, No. 10, 1966-9 (Oct., 1961).

During electron bombardment at 40°C, two fluorescence bands e near infrared were observed in many CdS crystals. The bands at about 8500 A and 1.05 μ. The 8500 A band was reduced in nsity by electron bombardment at 100 and 275 keV and by osure to X-radiation. The 1.05 μ band was not greatly affected hese irradiations. Heat treatment for ½ hr at 200°C partially tored the 8500 A band. The effect is interpreted as a redistribu- of electrons over the existing defects. The defect responsible the 8500 A band is believed to be copper in a particular ioniza- state. The 1.05 μ band was observed to appear after heat tment at 200°C if not present originally; this fact makes its in uncertain.

14654 TRANSPARENT LUMINESCENT FILMS BY SOLUTION SPRAYING.

R.D.Kirk and J.H.Schulman.

Electrochem. Soc. (USA), Vol. 108, No. 5, 455-7 (May, 1961).

Spraying solutions of zinc chloride or cadmium iodide with vator onto preheated Pyrex or silica glass yields cathodo- inescent films by direct reaction with the glass. The activated silicate films have excellent adherence, good transparency, and, on silica, a brightness comparable to that of evaporated films on Vycor. Films on silica require refiring in air.

14655 MODULATION OF THE LUMINESCENCE EXCITED BY α-RAYS IN CERTAIN ZINC SULPHIDES UNDER THE ACTION OF ALTERNATING FIELDS.

R.Henck and A.Coche.

J. Phys. Radium (France), Vol. 22, No. 1, 59-60 (Jan., 1961). In French.

The blue and orange emission bands from 88ZnS:12CdS:Mn under α-rays behave differently when an a.c. field is also applied. Somewhat unsymmetrical light waves with two maxima per cycle of the field are superimposed on the steady α-ray luminescence. For the orange band the whole wave is above the former level, its minima occurring when the applied field is near zero. For the blue band the average luminescence is reduced by the field, though the maxima of the light waves are above the level for α-ray excitation alone, and these maxima occur near the times of zero field. S.T.Henderson

14656 THE INTENSIFYING EFFECT OF ELECTRIC FIELDS ON α-RAY LUMINESCENCE AS A FUNCTION OF THE EMISSION WAVELENGTH AND THE FREQUENCY OF THE ELECTRIC FIELD.

R.Henck and A.Coche.

J. Phys. Radium (France), Vol. 22, No. 2, 98-100 (Feb., 1961). In French.

The intensifying effect of electric fields on α-ray excited phosphors of the type ZnS:CdS activated with Mn, was studied as a function of the emission wavelength of the phosphor and of the frequency (0.005 c/s to 50 kc/s) of the applied electric fields, for several concentrations of manganese.

14657 ELECTROLUMINESCENCE AT LOW VOLTAGE.

J.Weiszburg.

Acta phys. Hungar., Vol. 13, No. 1, 61-6 (1961).

It is usual to distinguigh between the intrinsic and the injection electroluminescence, because of the differences of the threshold voltages of their lighting. There is no foundation for this distinction because the orders of the threshold voltages of the two groups agree with each other. The electroluminescent phenomena of evaporated ZnS layers at low voltages can be described also by regularities characteristic of the Mott—Shottky-type barriers. The existing measuring data are not detailed enough to serve as a check of the correctness of the various theoretical hypotheses.

14658 LUMINESCENCE IN ELECTRIC FIELDS OF "DRY" OXIDE FILMS ON ALUMINIUM.

J.Wesołowski, M.Jachimowski and R.Dragon.

Acta phys. Polon. (Poland), Vol. 20, No. 4, 303-11 (1961).

The electrical and luminescent properties of electrolytically formed "dry" aluminium oxide films were investigated. Cells consisting of an aluminium base with oxide layer and transparent semiconducting coating were subjected to a d.c. field. The light emission from the oxide layers was observed. The luminescence brightness and cell current were measured against the applied voltage. The properties of dry aluminium oxide films strongly resemble, on the one hand, those of electrolytic cells and, on the other hand, those of typical electroluminescent cells. It is therefore assumed that in either case, the light emission may be considered to represent a process of electroluminescence.

14659 ELECTROLUMINESCENCE IN ZINC SULFIDE AS DUE TO MINORITY CARRIER INJECTION.

W.A.Thornton.

J. Electrochem. Soc. (USA), Vol. 108, No. 7, 636-45 (July, 1961).

Under the proper experimental conditions which can be fulfilled in conventional electroluminescent ZnS powder dispersions in dielectric material or in luminescent films, the restive component of the a.c. current follows the diode equation (for forward bias)

$$I = I'[\exp(V/V') - 1],$$

where v is the applied r.m.s. voltage. The parameter I' is proportional to $\exp(-E/kT)$ and V' is proportional to temperature and phosphor layer thickness. Three independent determinations give the number of active forward-biased junctions per micron of ZnS phosphor as about 15. The forward currents are shown to be directly related to electroluminescence emission and are compared directly to a.c. currents in Ge p—n junctions. Irradiation effects on the conductance of a phosphor layer and a Ge photojunction are compared. D.C. electroluminescence in ZnS at 2.0 V is also cited against the acceleration—collision theory, and the major arguments in its favour are discounted.

14660 AN ATTEMPT TO OBTAIN ELECTROLUMINESCENCE OF ORGANOPHOSPHORS.

H.Łożykowski and H.Męczyńska.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 235-6 (1961).

The same electroluminescence was observed from cellophane coloured by various organic dyes, and from the uncoloured material. S.T.Henderson

14661 EFFECT OF THE ACTIVATOR CONCENTRATION ON THE DEPTH OF ELECTRON TRAPS IN ZnS.

U.Szmyt and A.Wezesińska.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 11-12, 811-16 (1960). In French.

Thermoluminescence curves were measured from 120° to 350°K for ZnS phosphors with Cu activator concentrations of nil, 10^{-5}, 10^{-4} and 10^{-3} g/g. There is a systematic displacement of the glow peaks towards low temperatures as the activator concentration is increased, and the electron trap depths are deduced therefrom. J.B.Birks

14662 SPECTRAL COMPOSITION OF THERMOLUMINESCENCE OF COLOURED NaCl CRYSTALS.

J.Dolejši and A.Bohun.
Czech. J. Phys., Vol. 10, No. 7, 529-35 (1960).

The paper gives the experimental results of studying the spectral composition of thermoluminescence in the different maxima in photo-chemically coloured "pure" NaCl crystals or NaCl crystals containing Cu in different concentrations.

14663 THERMOLUMINESCENCE OF KCl AND NaCl AFTER X-RAY AND U.V. IRRADIATION AT HELIUM TEMPERATURES. F.Fischer.

Z. Phys. (Germany), Vol. 163, No. 4, 401-23 (1961). In German.

Glow curves of luminescence are recorded in the range 10°K to 300°K. Characteristic changes are obtained by previous annealing of single crystals in O_2 or HCl. Also an increase of the lattice disorder causes new glow bands. In KCl a strong glow band always appears at 40°K after irradiation by X-rays or ultraviolet light in the exciton band range. It is ascribed to trapped excitons, which become mobile at that temperature. For X-ray irradiated KCl, the glow curve of luminescence is compared with the electrical glow bands and with the concentration change of known defects. The half width ΔT of all glow bands is found to be proportional to the maximum temperature: $\Delta T = (0.08 \pm 0.02)\, T_m$.

MAGNETIC PROPERTIES OF SOLIDS

14664 REGULAR SUPERSTRUCTURES OF MAGNETIC TRANSLATIONAL LATTICES. H.Cofta.

Acta phys. Polon. (Poland), Vol. 19, No. 6, 759-71 (1960).

An attempt is made to discuss the magnetic superstructures from the point of view of spin-wave propagation. The classification of superstructures proposed by the author in earlier papers is developed more precisely, introducing symmetric and non-symmetric superstructures and dividing the former into regular and non-regular orders. The present paper deals with the regular order only. The discussion deals mainly with antiferromagnetic translational lattices, though the general conclusions hold also for ferri- and antiferrimagnetic superstructures. As the most characteristic property of regular superstructures, the author assumes the presence of alternating parallel ferromagnetic planes. Their existence allows the prediction of the phenomenon of superstructural anisotropy of spin-wave dispersion. The expected behaviour of spin waves in particular superstructures of cubic lattices is discussed in detail. The theoretical proofs of these hypotheses are given. A simple geometrical interpretation of Luttinger's method of description of superstructures is given.

14665 ORIGIN OF EFFECTIVE FIELDS IN MAGNETIC MATERIALS. R.E.Watson and A.J.Freeman.

Phys. Rev. (USA), Vol. 123, No. 6, 2027-47 (Sept. 15, 1961).

The origin of the effective magnetic fields at the nuclei of magnetic materials which have been determined by Mössbauer, nuclear magnetic resonance, electron paramagnetic resonance, specific heat, and nuclear polarization methods is investigated theoretically by means of the exchange polarization mechanism. Exchange-polarized iron series Hartree—Fock calculations wer carried out for (a) free ions and neutral atoms, (b) ions in a (cu crystalline field (as in a salt), and (c) spin densities and configurations which conform with energy band and neutron magnetic scattering observations for the ferromagnetic metals. The effective field data for metals, ferrites, rare-earth garnets, and salts are then discussed and it is shown that the dominant contribution to t effective field (in almost every case) arises from the (exchange) polarization of the core electrons by the spin density of the unpaired outer electrons. For the transition metals, the role of the conduction electrons is analysed including some new contributions not previously considered. The data for ions like Fe^{3+} and Mn^{2+} may be understood mainly on the basis of the core polarization term but such factors as covalent bonding, charge transfer, crystal field effects (such as distortions from cubic symmetry) must also be included. For ions like Fe^{2+} and Co^{2+} the(large) field due to unquenched orbital angular momentum must also be considered and several cases in which the orbital field dominates are discussed. The exchange polarization method and the accuracy of the analytic spin-polarized Hartree—Fock functions are discussed with regard to the sensitivity of the internal field to orbital descriptions, the effect of crystalline environments, and to expansion and contraction of the spin density. Each factor is investigated in detail by means of accurate exchange-polarized calculations. In conjunction with these studies a restricted Hartree—Fock calculation for Mn^{2+} was carried out (and is reported as an Appendix) which is more accurate than existing calculations and indicates the accuracy of earlier analytic Hartree—Fock calculations.

14666 LOCALIZED MAGNETIC STATES IN METALS. P.W.Anderson.

Phys. Rev. (USA), Vol. 124, No. 1, 41-53 (Oct. 1, 1961).

The conditions necessary in metals for the presence or absence of localized moments on solute ions containing inner-shell electrons are analysed. A self-consistent Hartree—Fock treatment shows that there is a sharp transition between the magnetic state and the nonmagnetic state, depending on the density of states of free electrons, the s—d admixture matrix elements, and the Coulomb correlation integral in the d shell; that in the magnetic state the d polarization can be reduced rather severely to non-integral values, without appreciable free electron polarization because of a compensation effect; and that in the nonmagnetic state the virtual localized d level tends to lie near the Fermi surface. It is emphasized that the condition for the magnetic state depends on the Coulomb (i.e., exchange self-energy) integral, and that the usual type of exchange alone is not large enough in d-shell ions to allow magnetic moments to be present. It is shown that the susceptibility and specific heat due to the inner shell electrons show strongly contrasting behaviour even in the non-magnetic state. A calculation including degenerate d orbitals and d—d exchange shows that the orbital angular momentum can be quenched, even when localized spin moments exist, and even on an isolated magnetic atom, by kinetic energy effects.

MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS.

See Abstr. 14402

14667 ORBITAL CONTRIBUTION TO THE MAGNETIC FORM FACTOR OF Ni++. M.Blume.

Phys. Rev. (USA), Vol. 124, No. 1, 96-103 (Oct. 1, 1961).

The effect of a residual orbital moment on the magnetic form factor of Ni^{2+} is calculated. It is shown that the ordinary form factor is replaced by a tensor, and formulae are given for the slow-neutron magnetic-scattering cross-sections of paramagnetic ferromagnetic, and antiferromagnetic Ni^{2+}. It is found that the unquenched orbital moment causes a 4% expansion of the form factor relative to the "spin-only" case, and that the anisotropic scattering is reduced by ~ 10%.

14668 SOME EFFECTS OF ANISOTROPY ON SPIRAL SPIN-CONFIGURATIONS WITH APPLICATION TO RARE-EARTH METALS. T.A.Kaplan.

Phys. Rev. (USA), Vol. 124, No. 2, 329-39 (Oct. 15, 1961).

A theoretical stude is made of effects of anisotropy on spiral spin-configurations, emphasizing the problem of the magnetic ordering in rare-earth metals. The principal results are as follo It is shown that the ferromagnetic spiral observed at low temperatures by Wilkinson et al. (Abstr. 6346-8 of 1961) in erbium can be

classical ground state of a spin Hamiltonian containing exchange
anisotropy terms, provided the latter includes terms of at least
fourth power in the spin variables. Furthermore, the observed
e angles (which imply large deviations from configurations poss-
with exchange forces alone) can be obtained with anisotropy
ces much smaller than the exchange forces. The spin-wave spec-
m and susceptibility for ferromagnetic spirals were also con-
ered. The former has the interesting properties that $\omega(\vec{k})$ is
ar in $\vec{k}$ for small $\vec{k}$ (even though the net moment is not zero), and
re are two distinct branches, as contrasted with the case of
iple antiferromagnetic spirals. For high temperatures, calcula-
is are made on the basis of the molecular field approximation.
s shown that a small easy-axis anisotropy implies that at the
hest transition temperature, T_C, the ordered spin configuration
static longitudinal spin wave; the average spins are collinear,
ir lengths varying sinusoidally through the crystal. As T de-
ases below T_C, the amplitude of the wave grows in order
$-T)^{1\ 2}$, other Fourier components entering in higher order. The
pendicular components remain zero until a second transition
nperature is reached, below which they begin to order. Since this
nplex type of behaviour, which has been observed in erbium, can
o occur with the same exchange and anisotropy constants needed
give the observed ground state, the possibility exists of describing
ium through the whole temperature range by this type of theory.

14669 PHENOMENOLOGICAL DISCUSSION OF MAGNETIC ORDERING IN THE HEAVY RARE-EARTH METALS.

J.Elliott.
ys. Rev. (USA), Vol. 124, No. 2, 346-53 (Oct. 15, 1961).

The rare-earth metals Gd–Tm have similar crystal structures
d their magnetic properties have been partially evaluated by a
mber of techniques. The magnetic order is complicated, showing
veral phases in some cases and differing considerably in the
rious elements. These various orderings can be explained on a
lecular field (Bragg–Williams) model if a long-range oscillatory
change interaction whose minimum Fourier component J(q) is at
$\neq$ 0, small quadrupole-quadrupole interaction, and anisotropy are
cluded. A crystal field calculation gives axial and hexagonal
isotropies which vary along the series in a way which accounts
r the observed structures. In Tb, Dy, and Ho the moment is
rced into the basal plane and the order is a spiral at high T,
coming ferromagnetic at low T because of the hexagonal aniso-
opy. The quadrupole–quadrupole interaction determines the
ange of pitch with T. In Er and Tm the moment is forced along
e c-axis and the observed order, with sinusoidal variation of this
oment, is found to have lowest free energy at high T. As T is
wered, transitions to an anti-phase domain structure and then to
rromagnetism are predicted.

14670 RELATIONSHIP BETWEEN CRYSTAL SYMMETRY AND MAGNETIC PROPERTIES OF IONIC COMPOUNDS CON-AINING Mn^{3+}.

.B.Goodenough, A.Wold, R.J.Arnott and N.Menyuk.
hys. Rev. (USA), Vol. 124, No. 2, 373-84 (Oct. 15, 1961).

An investigation was made of the relationship between crystallo-
raphic symmetry and $Mn^{3+}-O^{2-}-Mn^{3+}$ 180° superexchange inter-
ctions in several perovskite systems. In particular, crystallo-
raphic and magnetic measurements were made on a number of
amples in the systems $La(Mn_{1-x}M_x)O_{3+\delta}$, where M = Ga, Co, Ni.
all three systems, the $Mn^{3+}-O^{2-}-Mn^{3+}$ interactions are found to be
rromagnetic for O-orthorhombic samples having $a < c/\sqrt{2} < b$.
or $x < 0.5$ in the system M = Ga, there is O'-orthorhombic sym-
etry ($c/\sqrt{2} < a < b$) and ferrimagnetism that is suggestive of aniso-
ropic $Mn^{3+}-O^{2-}-Mn^{3+}$ interactions, similar to those found in
$aMnO_3$, and preferential ordering of the Ga^{3+} into one magnetic sub-
attice. Measurements of Curie temperature versus composition in
his system support ordering of the gallium in the compositional
ange $x \leq 0.4$, partial ordering in the range $0.4 < x \leq 0.6$. These
bservations are consistent with the magnetic measurements of
arious other workers on the systems $(La,M'^{2+})MnO_{3+\delta}$, $La(Mn,Cr)O_3$,
$La,Ba)(Mn,Ti)O_3$. The ferromagnetic Mn^{3+}–anion–Mn^{3+} interactions
hat occur in the perovskites with O-orthorhombic or rhombohedral
ymmetry and in the NiAs-type compounds cannot be accounted for
y present superexchange theory if the electron configuration about
Mn^{3+} ion is assumed fixed with one electron arithmetically aver-
ged over the two e_g orbitals, or if static, local distortions are
andomly distributed through the structure. It is pointed out that
ahn–Teller electronic ordering is fast relative to the atomic vibra-
ions so that there is strong coupling of the vibrational modes and
he e_g-electron configuration. This means that the electron configuration that is used in the superexchange calculation must be correlated with the vibrational modes. If this is done, a ferromagnetic Mn^{3+}–anion–Mn^{3+} interaction follows from the superexchange theory.

14671 MAGNETIC TRANSITION IN $TiCl_3$.

S.Ogawa.
J. Phys. Soc. Japan, Vol. 15, No. 10, 1901 (Oct., 1960).

The susceptibility of a polycrystalline specimen decreases suddenly below 217°K. At this temperature the lattice constant "a" also decreases, while "c" increases; this distortion is thought responsible for the magnetic transition. E.P.Wohlfarth

14672 THE DIRECT MEASUREMENT OF THE MAGNETIZATION ENTROPY OF A PARAMAGNETIC SUBSTANCE: THERMAL AND MAGNETIC PROPERTIES OF FERRIC METHYLAMMONIUM ALUM AT LOW TEMPERATURES.

A.J.Croft and R.H.B.Exell.
Proc. Roy. Soc. A (GB), Vol. 262, 110-19 (June 13, 1961).

A method is described for determining the magnetization entropy of a paramagnetic substance by the measurement of the heat absorbed by the sample during isothermal demagnetizations near 1°K. The method was used with ferric methylammonium alum, which deviates appreciably from ideal behaviour because of the large Stark splittings of the ground state of the Fe^{3+} ions. The results were found to agree within the experimental error with magnetization entropies computed from the energy levels of the ferric ions in a trigonal crystalline field. The computed entropies have been used to determine the absolute temperatures below 1°K reached by adiabatic demagnetizations of this salt.

14673 MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON TYPE A MYOGLOBIN CRYSTALS. F.R.McKim.

Proc. Roy. Soc. A (GB), Vol. 262, 287-90 (July 4, 1961).

Measurements were made of the difference between the magnetic susceptibilities in the directions of the a and b crystal axes in type A acid-met myoglobin crystals, at temperatures between room temperature and 90°K. Below about 150°K a measurable anisotropy has been found. This has been interpreted in terms of a splitting between the ground doublet and the first excited doublet of less than 15 cm^{-1}, compared with the earlier estimate from electron resonance work of the order of 10 cm^{-1} or greater.

14674 EFFECTS OF S–D EXCHANGE INTERACTION AND TEMPERATURE-INDEPENDENT PARAMAGNETISM ON SUSCEPTIBILITIES OF NICKEL, PALLADIUM AND PLATINUM.

M.Shimizu.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1114-22 (June, 1961).

The well-known discrepancy between the number of the Bohr magneton obtained from the saturation magnetization at 0°K and that obtained from paramagnetic susceptibilities for Ni is explained by taking into account the s–d exchange interaction, instead of the s–d electron transfer, and the temperature-independent paramagnetism due to the orbital moments of d electrons. The similar discrepency between the number of magnetic carriers obtained from the paramagnetic susceptibility measurement at lower temperatures and that at higher temperatures for Pd is explained in the same way. The same discussion is applicable to Pt. It is concluded that the temperature-independent paramagnetism is important in the explanation of the temperature variations of susceptibilities of transition metals. The paramagnetic susceptibilities for Ni, Pd, and Pt at higher temperatures are expressed in the form, $C/(T-\theta_p)+\chi_C$. The temperature-independent susceptibility, χ_C, is the sum of the paramagnetic susceptibility of the conduction electron (or s electron) spins and that due to the orbital moment of d electrons.

14675 SIZE-DEPENDENT RELAXATION TIMES AT LIQUID HELIUM TEMPERATURES. F.R.Nash.

Phys. Rev. Letters (USA), Vol. 7, No. 2, 59-61 (July 15, 1961).

The salt used was $Cu(NH_4)_2(SO_4)_2\ 6H_2O$ and crystals were prepared in two ways, by slow growth over 24 hours and by rapid growth from a supersaturated solution (~ 1 min). For the quickly grown crystals, τ was proportional to the size for crystal sizes less than 200μ. For sizes greater than 500μ, τ was independent of size. For the slowly grown crystals $\tau \propto$ (size) up to 900μ. A tentative explanation is given in terms of phonon imprisonment (Abstr. 9803 of 1959). D.J.Oliver

14676 TEMPERATURE DEPENDENCE OF MAGNETIC SUSCEPTIBILITIES OF KClO$_3$, KBrO$_3$ AND KIO$_3$.

S.Tobisawa.
J. Phys. Soc. Japan, Vol. 16, No. 4, 654-7 (April, 1961).

Susceptibilities of crushed samples were measured with a recording magnetic balance which was operated by the Faraday method. The temperature was elevated at a constant rate, 250 deg C per hr. It was found that, being heated, KClO$_3$ showed irregular paramagnetic susceptibilities in the solid or liquid state, before the evolution of oxygen gas at 500°C. A possible explanation for the irregular paramagnetic behaviours is suggested. On the contrary, KBrO$_3$ and KIO$_3$ showed the diamagnetic susceptibilities, which were independent of temperature below the temperatures of the evolution of oxygen gas, 370° and 550°C, respectively.

14677 MAGNETIC MEASUREMENTS ON PURE MnCO$_3$, PURE MnO AND DISSOCIATING MnCO$_3$.

J.A.Poulis, C.H.Massen and P. van der Leeden.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 133-40 (1961).

With a sensitive balance, susceptibility was measured on dissociating MnCO$_3$. The susceptibility of pure MnCO$_3$, which was the initial material, followed the Curie–Weiss law; pure MnO, from complete dissociation, showed deviations from this law. The recombination of MnO with the collected CO$_2$ was studied, the results leading to a hypothesis concerning the reaction mechanism of dissociation and recombination.

14678 MAGNETIC PROPERTIES OF PEROVSKITES CONTAINING STRONTIUM, II. LANTHANUM–STRONTIUM MANGANITES. H.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 3, 433-9 (March, 1961).

For Pt I, see Abstr. 8129 of 1958. The magnetic and crystallographic properties of the system (La$_{1-y}$Sr$_y$)MnO$_x$ with varying values of y and x were studied. It is found that the compounds with y = 1 crystallize in the perovskite-like structures provided that x is lower than a certain limit. Perovskite-like SrMnO$_x$, containing both Mn^{3+} and Mn^{4+} does not show any spontaneous magnetization above the liquid N$_2$ temperature, and its paramagnetic Curie temperature is negative, in contrast with the well-known ferromagnetic behaviour observed in La-rich manganites. Hence in these compounds no evidence of strong positive Mn^{3+}–Mn^{4+} interaction is obtained. The susceptibility measurements show that the Mn^{3+}–Mn^{3+} interaction in Sr-rich cubic perovskite is negative. This fact is consistent with Jonker's results that in cubic perovskite manganites such as (La, Ca)MnO$_3$, Mn^{3+}–Mn^{3+} interaction is positive for large cell dimensions while it is negative for small cell dimensions.

14679 THE VARIATION WITH TEMPERATURE OF THE MAGNETIC SUSCEPTIBILITY OF SOME OF THE TRANSITION ELEMENTS.

H.Kojima, R.S.Tebble and D.E.G.Williams.
Proc. Roy. Soc. A (GB), Vol. 260, 237-50 (Feb. 21, 1961).

The paramagnetic susceptibility χ of some of the transition elements in the temperature range 20 to 1800°C was measured. The values of χ at 20°C in 10^{-6} e.m.u./g are: Ti, 3.36; Zr, 1.33; Hf, 0.38; V, 5.64; Nb, 2.3; Ta, 0.85; Mo, 0.82; W, 0.29; Re, 0.35; Ru, 0.34; Rh, 1.03; Ir, 0.14; Pd, 5.4; Pt, 0.97. It was found that the generalization proposed by Kriessman and Callen (1954), that the temperature gradient of χ alternates in sign in successive columns of the periodic table, is not supported by the results of this work. The results are discussed in relation to the band theory of metals and some generalizations about the d-band forms of the three transition metal series are made.

14680 THE EQUIVALENCE OF HAMILTONIANS OF HOLSTEIN–PRIMAKOFF AND DYSON IN SPIN-WAVE THEORY IN FERROMAGNETISM. T.Oguchi.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 721-2 (April, 1961).

These Hamiltonians are shown to be completely equivalent.

J.F.Cornwell

14681 ON THE MAGNETICALLY DILUTE HEISENBERG AND ISING FERROMAGNETICS.

G.S.Rushbrooke and D.J.Morgan.
Molecular Phys. (GB), Vol. 4, No. 1, 1-15 (Jan., 1961).

The lowering of the Curie temperature of a ferromagnetic substance by random dilution with non-magnetic elements is studied on the basis of Heisenberg and Ising models having nearest-neighbour interactions between magnetic elements only. It is proved that the limiting concentration, p_C, of magnetic elemen below which there is no Curie temperature, is the same for al models, whether Heisenberg or Ising and regardless of the spi value concerned: it depends only on the lattice structure. Nu al estimates of p_C are given for various lattices. Successive a imations are developed to the full Curie temperature curve, and it is found that whereas for the Ising model $T_C(p)$ approximates t $pT_C(1)$ near $p = 1$, $T_C(p) < pT_C(1)$ for the Heisenberg model.

STATISTICAL PROPERTIES OF THE ELECTRON SYSTE OF FERROMAGNETIC TRANSITION METALS. See Abstr. 14[illegible]8

14682 MAGNETIC PROPERTIES OF INTERMETALLIC COMPOUNDS IN IRON-GERMANIUM SYSTEM: Fe$_{1.67}$Ge AND FeGe$_2$. K.Yasukōchi, K.Kanematsu and T.Ohoya

J. Phys. Soc. Japan, Vol. 16, No. 3, 429-33 (March, 1961).

The magnetic properties of the two intermetallic compoun β phase (Fe$_{1.67}$Ge) and δ phase (FeGe$_2$), in the Fe–Ge system, we investigated. The β phase has B8$_2$ type of crystal structure an s ferromagnetic with the Curie point 485°K, saturation magnetiz at 0°K 1.59 μ_B, and paramagnetic moment 3.14 μ_B per iron ato. The δ phase has a C16 type of crystal structure and exhibits a parasitic ferromagnetic behaviour in which the Néel point, asy Curie point, saturation magnetization at 0°K, and the paramagn moments are 190°K, +90°K, 0.11 μ_B, and 2.43 μ_B, per iron ato respectively. Brief discussions on the magnetic structures ar given.

14683 THE THEORY OF LOW-TEMPERATURE, HIGH-FREQUENCY MAGNETIC SUSCEPTIBILITY OF A FERRODIELECTRIC.

I.A.Akhiezer, V.G.Bar'yakhtar and S.V.Peletminskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 365-74 (Jan., 196
In Russian.

Quantum field theory methods are used to evaluate the tran verse components of the magnetic susceptibility tensor of a fer dielectric, taking both the exchange and the relativistic interact between spin-waves into account. The ferromagnetic resonance width is found. It is shown that a knowledge of the magnetic su ibility enables one to study the relaxation of the magnetic mom of a ferrodielectric. The transverse relaxation time is evaluat [English translation in: Soviet Physics—JETP (USA), Vol. 13, N 249-55 (July, 1961)].

14684 A STUDY OF THE MAGNETIC PROPERTIES OF IR IN RELATION TO ITS COLOURING ACTION IN GLA I. IRON IN SODIUM BORATE GLASSES MELTED UNDER OXIDIZING CONDITIONS. C.R.Bamford.

Phys. Chem. Glasses (GB), Vol. 1, No. 5, 159-64 (Oct., 1960).

The variation with temperature of the magnetic susceptibili of sodium borate glasses containing various amounts of added i oxide and melted under oxidizing conditions was studied over th temperature range 20 to 400°C. A complementary study was th optical transmission properties of the glasses in the visible and near infrared regions of the spectrum. It is deduced that two fo of iron are present in the glasses, namely (1) "colloidal" ferric oxide or, as a preferable description, a uniform dispersion of undissolved ferric oxide of fine particle size, giving a yellow or brown colouring to the glass, and (2) as Fe^{3+} ions or some comp of Fe^{3+} ions having the same number of unpaired electron spins the central iron ion. The inference is that the ligand field affect the Fe^{3+} ions is at most of medium strength. Any colouring acti of the Fe^{3+} ions is masked by that of the "colloidal" ferric oxide The proportion of iron as "colloidal" ferric oxide increased as t sodium oxide concentration in the glasses decreased and also as total iron concentration increased.

14685 A STUDY OF THE MAGNETIC PROPERTIES OF IRO IN RELATION TO ITS COLOURING ACTION IN GLA II. IRON IN SODIUM BORATE GLASSES MELTED UNDER REDUCING CONDITIONS. C.R.Bamford.

Phys. Chem. Glasses (GB), Vol. 1, No. 5, 165-9 (Oct., 1960).

The variation with temperature of the magnetic susceptibili sodium borate glasses containing known amounts of added iron a melted under reducing conditions was studied over the temperat range 20 to 400°C. A complementary study was the optical tran mission properties of the glasses in the visible and near infrare regions of the spectrum. The oxidizing action of boric oxide prevented the attainment of completely reducing conditions. It i deduced that three forms of iron are present in the glasses, nam (1) as "colloidal" ferric oxide or, as a preferable description, a rm dispersion of undissolved ferric oxide of fine particle size, g a brown colouring, and (2) as Fe^{3+} and (3) Fe^{2+} ions, or such tion" complexes of these ions to maintain in each case the er of unpaired electron spins associated with the ionic ition. The inference from this is that ligand field affecting ron ions is at most of medium strength. The proportion on present as "colloidal" ferric oxide increased as the m oxide concentration of the glasses decreased and also e amount of iron originally added to the melt increased. The entrations of "colloidal" ferric oxide are approximately halved e use of reducing conditions as compared with the same glass ed under oxidizing conditions as described in Pt I. Iron in the ous form increased as the sodium oxide content of the glasses eased.

4686 THE INFLUENCE OF OXIDATION AND REDUCTION ON THE PARASITIC FERROMAGNETISM OF α Fe_2O_3.

asaki, K.Siratori and S.Iida.

hys. Soc. Japan, Vol. 15, No. 8, 1535 (Aug., 1960).

A temperature-independent part of the parasitic magnetization shown to depend on departure of the cation—anion ratio from chiometry and is the same as Néel's isotropic term. mechanism is not clear. D.J.Oliver

4687 LOCAL MAGNETIC FIELDS IN Fe—Al ALLOYS.

P.A.Flinn and S.L.Ruby.

s. Rev. (USA), Vol. 124, No. 1, 34-6 (Oct. 1, 1961).

In apparent contrast with recent results on Fe—Co and -Ni alloys, the Mössbauer spectra in ferromagnetic Fe—Al ys are both blurred and contracted as the fraction of aluminium ms is increased. This phenomenon is consistent with a model re the inner field at a given iron atom depends strongly on number of aluminium nearest neighbours.

14688 THE MAGNETIC PROPERTIES OF Mn—Sn—C ALLOYS.

M.Asanuma.

Phys. Soc. Japan, Vol. 15, No. 6, 1136-7 (June, 1960).

For alloys with a composition $Mn_{3+x}X_{1-x}C$, three nganese atoms occupy the f.c.c. positions with a magnetic ment of 0.7 μ_B and the excess x atoms occupy positions at the e corners with an antiparallel moment of 0.85 μ_B. The Curie perature increases with decrease of lattice parameter.

D.J.Oliver

14689 ON THE FERROMAGNETISM IN MANGANESE-ALUMINIUM-IRON SYSTEM.

suboya and M.Sugihara.

Phys. Soc. Japan, Vol. 15, No. 8, 1534 (Aug., 1960).

Specimens in the range 35 to 47.5 at.% Mn, 40 to 47.5 at.% Al 10 to 17.5 at.% Fe are ferromagnetic and have the ordered Cl structure with a lattice constant of 2.96-2.97 A. Details saturation magnetization and Curie temperature are given.

D.J.Oliver

14690 ON THE NEW MAGNETIC PHASE IN MANGANESE—ALUMINIUM—COPPER SYSTEM.

Tsuboya and M.Sugihara.

Phys. Soc. Japan, Vol. 16, No. 3, 571 (March, 1961).

A new ferromagnetic phase in the Mn—Al—Cu system is ported. It has a cubic structure, the same as the K phase of e Mn—Al—Fe system. The magnetic properties vary with mposition; at 40 at.% Mn, 40 at.% Al and 20 at.% Cu the Curie mperature is 550°K and the saturation magnetization is 160 e.m.u.

H.Mykura

14691 WEAK FERROMAGNETISM IN β-$NaFeO_2$.

H.Watanabe and M.Fukase.

. Phys. Soc. Japan, Vol. 16, No. 6, 1181-4 (June, 1961).

The high temperature modification of sodium ferrite, β-$NaFeO_2$, as weak ferromagnetism, whose Curie temperature is about 450°C. he magnetic property resembles that of $LaFeO_3$. The origin of is weak ferromagnetism can be attributed to the presence of the zyaloshinsky type interaction in this compound (Abstr. 3224 of 958).

14692 MAGNETIC PROPERTIES OF NICKEL.

G.C.Fletcher.

roc. Phys. Soc. (GB), Vol. 78, Pt 1, 145 (July, 1961).

Corrects errors in previous papers (Abstr. 7560 of 1954; 240 of 1956). D.J.Oliver

14693 FERROMAGNETIC ANOMALY OF THE WORK FUNCTION OF NICKEL.

A.Gel'berg, B.Iosifesku and G.Komsha.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1074-8 (April, 1961). In Russian.

The temperature-dependence of the work function of Ni (determined with and without compensating the terrestrial magnetic field) was shown to have a deflection at the Curie point which confirmed Vonsovskii's theory (Abstr. 3629 of 1951) on the dependence of work function on spontaneous magnetization. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 783-5 (Oct., 1961)]. M.H.Sloboda

14694 MAGNETIC COMPOUNDS OF HEXAVALENT RHENIUM WITH THE PEROVSKITE-TYPE STRUCTURE.

J.Longo and R.Ward.

J. Amer. Chem. Soc., Vol. 83, No. 13, 2816-18 (July 5, 1961).

Phases of composition $A^{II}(B_{0.5}^{II}Re_{0.5}^{VI})O_3$ were prepared by interaction of metal oxides under controlled conditions. When A^{II} is barium and B^{II} represents the divalent cations Ca, Mg, Mn, Fe, Co, Zn and Cd, the compounds are all of the cubic ordered perovskite type. The compounds with manganese and iron are magnetic. Substitution of strontium and calcium in the A position when B^{II} is iron leads to distorted structures apparantly related to the cubic perovskite type. The approximate Curie temperatures for the magnetic phases were determined.

14695 THE TEMPERATURE DEPENDENCE OF THE CRYSTAL ANISOTROPY CONSTANTS AND SPONTANEOUS MAGNETIZATION OF HEXAGONAL COBALT.

Y.Barnier, R.Pauthenet and G.Rimet.

C. R. Acad. Sci. (France), Vol. 252, No. 19, 2839-41 (May 8, 1961). In French.

Measurements in fields of up to 20 000 Oe from 2.4 to 668°K give J_0 = 1442 e.m.u./cm^3 (i.e. 1.72 μ_B per atom). The temperature dependence of K_1 and K_2 does not show good agreement with theory. M.A.Taylor

14696 FERROMAGNETIC CRYSTALLINE ANISOTROPY OF $MeFe_2O_4$—Fe_3O_4 FERRITE SOLID SOLUTIONS.

N.Miyata.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1291-8 (July, 1961).

Ferrite crystals of the ternary system $(Mn_xFe_yNi_z)Fe_2O_4$, where $x + y + z = 1$, were grown by the Bridgman method in the air. According to the X-ray analysis, they have the spinel structure, except in the region near $NiFe_2O_4$, and their lattice constants depend linearly on the concentration: $a = (8.518 - 0.125y - 0.176z) \pm 0.005$ A. The ferromagnetic crystalline anisotropy was measured by the torque method in the temperature range between 90°K and 300°K. In normal specimens K_1 decreases with decreasing temperature. $NiFe_2O_4$—Fe_3O_4 system shows an anomalous temperature dependence for a wide range of concentration: K_1 increases and changes its sign from negative to positive at low temperature. This may be due to the short range order of Fe^{2+} and Fe^{3+} at the octahedral site of the spinel lattice. If such an anomaly is subtracted, K_1 of the ternary system becomes maximum at a certain Fe_3O_4 concentration. This can be attributable to the special contribution of the Fe^{2+}-ion. The crystals of $(Zn_{1-y}Fe_y)Fe_2O_4$ binary system were also investigated. They have the spinel structure with the lattice constant of $a = (8.445 - 0.052y) \pm 0.005$ A. The relation of the anisotropy constant to y also indicates the contribution of Fe^{2+} mentioned above.

14697 ON THE MAGNETIC ANISOTROPY AND SUSCEPTIBILITY OF $Fe(NH_4SO_4)_2,6H_2O$.

A.Bose, A.S.Chakravarty and R.Chatterjee.

Proc. Roy. Soc. A (GB), Vol. 261, 207-14 (April 25, 1961).

The theory of magnetic anisotropy and susceptibility of Fe^{2+} in Tutton salts is worked out on the basis of Abragam and Pryce's method. It is found that the anisotropic part of the crystal field changes with temperature owing to the thermal expansion of the crystal lattice. The spin-orbit coupling coefficient has to be decreased by ~ 20% from its free ion value of -103 cm^{-1} which indicates some amount of overlap between the 3d-Fe^{2+} and s- and p-O^{2-} charge clouds. The agreement of the theoretical values with the experiment is good within the limitations of the approximations involved.

14698 CRYSTALLINE ELECTRIC FIELDS IN HYDRATED Co^{2+} SALTS.

A.Bose, A.S.Chakravarty and R.Chatterjee.

Proc. Roy. Soc. A (GB), Vol. 261, 43-52 (April 11, 1961).

The theoretical expressions for the magnetic susceptibility and anisotropy of Co^{2+} ion in hexahydrated salts have been derived on the basis of Abragam and Pryce's theory and compared with the experimental results for three Tutton salts. Agreement with experiment is very good provided it is assumed that for each salt the value of the asymmetric field separation Δ varies with temperature. It appears that the magnitude of Δ depends more upon the alkali radicals than upon the acid radicals. The value of the spin—orbit coupling coefficient ζ in Co^{2+} salts is practically the same as the free ion value, indicating very little overlap between the 3d-Co^{2+} and s- and p-O^{2-} charge clouds. The cubic and anisotropic field parameters G, H and I are different for divalent Co^{2+} and trivalent V^{3+}, as is to be expected.

14699 THE FIELD DEPENDENCE OF THE MAGNETIZATION OF SINGLE-CRYSTAL COBALT.

Y.Barnier, R.Pauthenet and G.Rimet.

C.R. Acad. Sci. (France), Vol. 252, No. 20, 3024-6 (May 15, 1961). In French.

$J_{\parallel}$ and $J_{\perp}$ for a single crystal of hexagonal cobalt were measured at 15°C for different orientations of an applied magnetic field. The results are in good agreement with the theory of Néel.

M.A.Taylor

14700 INVESTIGATIONS ON 50% IRON—COBALT ALLOYS.

G.Hellbardt.

Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960)p. 197-201. In German.

The magnetic properties of alloys containing equal quantities of iron and cobalt and 2% of vanadium are described. The coercivity and Vickers hardness show a pronounced minimum as the specimens are heated through the recrystallization temperature. In the texture of rolled materials the face diagonals are found to lie along the rolling direction and the body diagonals at right angles to it. The coercivity is about twice as large in the rolling direction as in a direction perpendicular to it. Below 700° a superstructure of the CsCl type appears in these materials and leads to brittleness, increase in coercivity and decrease in electric conductivity and remanence. The coercivity of a specimen heated to different temperatures and then cooled shows a maximum for 700°. The remanence shows a minimum. D.S.Parasnis

14701 TECHNICAL MAGNETIZATION OF FRAME-SHAPED SINGLE CRYSTALS OF SILICON IRON.

H.Kimura and E.Tatsumoto.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 1, 61-72 (July, 1960).

Non-ideal behaviour is observed because of the presence of serious crystal imperfections, the material having been prepared from a commercial silicon-iron sheet. Explanations in terms of domain theory are given. D.J.Oliver

14702 WEAK FERROMAGNETISM OF $NaNiF_3$.

S.Ogawa.

J. Phys. Soc. Japan, Vol. 15, No. 12, 2361 (Dec., 1960).

This is an orthorhombic structure with a most probable space group of D_{2h}^{16} - Pbnm. The magnetization of a polycrystalline specimen is expressed as $\sigma = \sigma_0 + \chi H$ below 150°K. The magnetic torques, L, of a single crystal in the planes containing the c-axis have an angular dependence $L = \pm\sigma_0 H \sin\theta$ below 149°K. Near the direction perpendicular to the c-axis the torque was unstable and suddenly changed sign. In the plane perpendicular to the c-axis the torque has two-fold symmetry, of amplitude approximately proportional to H^2. The torque measurements suggest that σ_0 appears in the c-direction and is not rotated towards the b-direction but is in some degree rotated towards the a-direction by applied fields up to 10 kOe. Some rare-earth orthoferrites show similar torque behaviour and these have been discussed by Bozorth. His arguments can be applied in this case. F.E.Hoare

14703 THE EFFECT OF CATION VACANCIES ON THE MAGNETIC ANNEALING OF $Co_xFe_{3-x}O_4$.

T.Inoue, H. Mizuta and S.Iida.

J. Phys. Soc. Japan, Vol. 15, No. 10, 1899-1900 (Oct., 1960).

Polycrystalline specimens containing various concentrations of cation vacancies were prepared and the final magnitudes of the anneal—induced anisotropy K and the relaxation time were measured. Although the cation concentration affects the rate of cation migration it does not affect the final magnitudes of K provided that the specimens are homogeneous. C.A.Hogarth

14704 THERMOREMANENT MAGNETIZATION. I. EXPE MENTS ON SINGLE DOMAIN GRAINS. C.W.F.Eve

Phil. Mag. (GB), Vol. 6, 713-26 (June, 1961).

This paper describes an attempt to test certain predictio Néel concerning the properties of thermoremanent magnetizat in fine-grained materials. The method of investigation was to examine the effects of alternating-field demagnetization on a specimen which had been given partial and total thermoreman A positive correlation was found between the blocking tempera and coercive force of individual magnetic grains in accordance a prediction of Neel's. In confirmation of another of Neel's pr- dictions, the ratio j_T/j_S of thermoremanence to spontaneous magnetization in grains with a particular blocking temperatur was found to be proportional to the hyperbolic tangent of the magnetizing field; whilst in apparent disagreement with a thir prediction j_T/j_S was found to be independent of the coercive f of the grains. In addition the blocking temperatures were foun to be almost independent of the magnetizing field up to 50 oers

14705 AN EXPERIMENTAL DEMONSTRATION OF THE PRODUCTION OF CHEMICAL REMANENT MAGNETIZATION WITH Cu—Co ALLOY. K.Kobayashi.

J. Geomagn. Geoelect. (Japan), Vol. 12, No. 3, 148-64 (1961).

Magnetization-blocking process in chemical remanent mag tion was demonstrated through the size development of ferromagnetic precipitates generated by an aging of Cu—Co alloy, t magnetic behaviour of which changes from super-paramagnetic stable single domain and then to multidomain, according to the increase in the size of the precipitates. It was shown that a remanent magnetization is acquired during the transition from superparamagnetic to stable ferromagnetic state and that the ramanent magnetization thus obtained decreases as a result of formation of domain walls if the size of the precipitates exceed the critical single domain grain size. The result can be well ex ed by Néel's thermal fluctuation theory of single domain grains the domain structure theory of ferromagnetics. The particle s at various stages of aging were estimated by different granulo methods with roughly consistent results. The general idea con in the present study has been successfully extended to the CRM phenomena in synthetic and natural ferromagnetic minerals. It suggested that specimens produced by low temperature chemic changes can be classified into four groups; the superparamagne stage, magnetically-stable single domain stage, the transient s from single domain to multidomain structure and the perfectly developed multidomain stage from the view-point of the nucleat of ferromagnetic minerals. The magnetic behaviour of several specimens already reported can be consistently interpreted on basis of the present experiment.

14706 MAGNETIC DOMAINS.

D.J.Craik and R.S.Tebble.

Rep. Progr. Phys. (GB), Vol. 24, 116-66 (1961).

The paper gives a survey of developments over the last de in the methods of investigation into the structure of ferromagne domains and the authors discuss the results in relation to prese day theoretical ideas on domain structure. Examples of the application of methods using Bitter patterns, electron microsc and magneto-optical effects are given for a wide variety of mat ranging from metallic single crystals to polycrystalline ferrite

14707 THE THICKNESS DEPENDENCE OF THE DOMAIN STRUCTURE OF MAGNETOPLUMBITE.

J.Kaczér and R.Gemperle.

Czech. J. Phys., Vol. 10, No. 7, 505-10 (1960).

The changes in domain structure as a function of the thickn of the crystal were studied on artificial magnetoplumbite cryst $PbFe_{12}O_{19}$. The thickness dependence of the width of the domai was also studied; up to thicknesses of about 10μ it follows the theoretical half-power law. Above 10μ the exponent is 0.633. energy density of the Bloch walls $\gamma = 4.82$ erg cm^{-2} and the exchange constant $A = 0.66 \times 10^{-6}$ erg cm^{-1} are calculated on t basis of the above measurements.

14708 TRANSFORMATION OF DOMAIN STRUCTURES B APPLIED VOLTAGES. C.Greiner.

Z. angew. Phys. (Germany), Vol. 13, No. 3, 134-6 (March, 1961 In German.

The motion of Bloch walls in Ni—Fe wires under the influe of applied electric fields is described and discussed. C.A.Ho

1709 THE DOMAIN STRUCTURE OF ORDERED PLATINUM—COBALT ALLOY. D.J.Craik and F.Nuñez.
. Phys. Soc. (GB), Vol. 78, Pt 2, 225-32 (Aug., 1961).

The domain structures in ordered regions of equiatomic
num—cobalt are found to be typical of materials with high uni-
anisotropy and low saturation magnetization. The distribution
e easy axes of discrete ordered regions within each grain con-
s previous work on the nature of the ordering. The width of the
ins is approximately accounted for in terms of the known pro-
es of the material, and their behaviour in applied fields shown
semble that of other uniaxial materials.

1710 EFFECT OF STRESS ON STABLE DOMAIN WALL ORIENTATIONS. T.Harada.
i. Hiroshima Univ. A (Japan), Vol. 24, No. 1, 55-9 (July, 1960).

Experiments were carried out by applying stresses along the
⟩ direction on single crystals of iron and 1.08% Si—Fe. The
lts were roughly in agreement with Graham and Neurath's
ictions (Abstr. 6036 of 1958). D.J.Oliver

4711 THE ROTATION OF BLOCH WALLS.
J.Kaczér and R.Gemperle.
h. J. Phys., Vol. 11, No. 3, 157-70 (1961).

A Bloch wall has an integral magnetic moment which is due to
spatial distribution of the magnetic moments of the spin. The
rnal magnetic field thus acts on the wall with a torque, which
s to the rotation of the "sub-domains" and therefore to deforma-
of the walls. A theory of this rotation is given and from it a
rophysical model of the undulatory surface structure in uniaxial
omagnets is derived. Experiments performed on magnetoplumb-
single crystals confirm the theoretical assumptions.

14712 THE CHARACTERISTIC-VOLTAGE ENERGY OF THE BLOCH WALL. M.Hieke, E.Max and H.G.Müller.
ngew. Phys. (Germany), Vol. 13, No. 3, 125-30 (March, 1961).
erman.

"Ferromagnetism Working Party" Wiesbaden, 1960 (see Abstr.
6 of 1961). Bloch walls impose on the magnetostrictive effect a
racteristic voltage, whose energy for a stationary Bloch wall is
ulated and indicates the conditions of motion of a mobile Bloch
l. Deviations from the theories of Sixtus and Tonks shown by
el—iron alloys are analysed. C.A.Hogarth

14713 DEPENDENCE OF ENERGY AND ORIENTATION OF 90° BLOCH WALL ON STRESS. J.Kaczér and M.Zelený.
ch. J. Phys., Vol. 10, No. 8, 561-7 (1960).

The energy and orientation of a 90° Bloch wall are calculated
functions of the stress. The relative occurrence of stress in a
nched single crystal of silicon—iron is derived on the basis of
experimental distribution of the zigzag angle.

14714 NUMERICAL EVALUATION OF FUNCTIONS OCCURRING IN A STUDY OF DOMAIN CONFIGURA-
N IN THIN LAYERS OF $BaFe_{12}O_{19}$.
.W.Duijvestijn and B.P.A.Boonstra.
lips Res. Rep. (Netherlands), Vol. 15, No. 4, 390-3 (Aug., 1960).

Two functions occurring in the theory of domain configuration in
layers of $BaFe_{12}O_{19}$ are evaluated numerically and presented
phically.

14715 SOME OBSERVATIONS ON THE DOMAIN WALLS IN THIN FILMS. Y.Gondo and Z.Funatogawa.
Phys. Soc. Japan, Vol. 15, No. 6, 1126-7 (June, 1960).

A report of a number of factual observations on the deposition
20% Fe—Ni films of varying thickness. The thickness range was
A to 4000 A, the temperature from room to 300° C, and the
essure 3×10^{-5} mm Hg. T.C.Toye

14716 ON THE FERROMAGNETISM OF THIN FILMS.
A.Corciovei.
ech. J. Phys., Vol. 10, No. 8, 568-78 (1960).

The magnetic properties of ferromagnetic thin layers are
died by calculating the partition function for the magnetic system
Kirkwood's approximation of the second order. The results
tained for the Curie temperature and the magnetization are in
mewhat better agreement with the experiment than those obtained
Valenta.

14717 NONLINEAR EFFECTS OF Z-DIRECTED SPIN WAVES IN THIN FILMS. J.I.Kaplan.
J. appl. Phys. (USA), Vol. 32, No. 10, 1831-3 (Oct., 1961).

The high-power instability is calculated of the Z-directed spin waves in a thin insulating ferromagnetic film. For complete pinning, the critical field is found to be

$$(\gamma h)^2 = \Delta_n{}^3 n^2 \pi^2 [9\sqrt{3}(\omega_M + \tfrac{1}{3}\omega_{ex} a^2 k_n{}^2)]^{-1}.$$

The calculation is also made for the critical field, assuming a mixed boundary condition.

14718 THE DEPENDENCE OF THE UNIAXIAL MAGNETIC ANISOTROPY IN EVAPORATED FILMS ON THE ANGLE OF INCIDENCE. V.Kamberský, Z.Málek, Z.Frait and M.Ondris.
Czech. J. Phys., Vol. 11, No. 3, 171-8 (1961).

The methods of local ferromagnetic resonance and direct torsional measurements were used to measure the dependence of the magnetic anisotropy in permalloy films on the angle of incidence in a broad range of such angles. It was found that this dependence is not monotonous and that at larger angles of incidence the easy axis of magnetization is rotated. An interpretation of this phenomenon is proposed.

14719 MEASUREMENTS ON THE MAGNETIC ANISOTROPY IN EVAPORATED IRON FILMS.
R.Vrambout and L.De Greve.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 102-6 (1961).

The magnetic anisotropy in evaporated iron films was examined by use of the magneto-optic Kerr effect. It was found that there exists a weak anisotropy in some iron films due to mechanical stresses.

14720 EFFECT OF CATHODIC HYDROGEN ON THE MAGNETIC PROPERTIES OF THIN ELECTROLYTIC NICKEL FILMS. L.Kozłowski and S.Kubiak.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 5, 409-17 (1961).

Magnetization, magnetic remanence and coercive force were measured for various hydrogen contents and film thickness. The maximum hydrogen absorption (0.55 H atoms per Ni atom) gives a minimum magnetization of 0.29 μ_B per Ni atom; this indicates that hydrogen gives electrons to both 3d- and 4s-bands. The coercive force increases as hydrogen is absorbed. M.A.Taylor

14721 PARTIAL ROTATION IN PERMALLOY FILMS.
S.Methfessel, S.Middelhoek and H.Thomas.
J. appl. Phys. (USA), Vol. 32, No. 10, 1959-63 (Oct., 1961).

Magnetization reversal at an angle to the easy direction was studied in Permalloy films with different values of coercive force H_C and anisotropy field H_K. The hysteresis properties show that "inverted" films ($H_C > H_K$) do not represent a special case, but that every film exhibits inversion in a certain sector of field directions. In the inversion sector, two critical field values are observed. The corresponding Bitter patterns make it evident that the lower critical field is due to a partial rotation process which is accompanied by a splitting of the film into many fine domains, whilst the higher one is due to wall motion. The observed processes can be understood qualitatively if the dispersion of the local values of the anisotropy field and ansisotropy direction, as well as the internal exchange and stray field coupling are taken into account.

14722 MAGNETORESISTANCE EFFECT IN THE MAGNETIZATION REVERSAL OF PERMALLOY FILMS. E.Tatsumoto, K.Kuwahara and M.Goto.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1703 (Sept., 1960).

Magnetoresistance measurements were used to obtain the magnitude of the anisotropy field as well as indications of its local variation. E.P.Wohlfarth

14723 ANGULAR DEPENDENCE OF TORQUE IN ANISOTROPIC PERMALLOY FILMS.
W.D.Doyle, J.E.Rudisill and S.Shtrikman.
J. appl. Phys. (USA), Vol. 32, No. 9, 1785-7 (Sept., 1961).

The results are for a film of thickness 1500 A, and 77% Ni permalloy. In the easy direction, the hysteresis loop was rectangular with $H_c = 1$ Oe and in the hard direction the magnetization curves was reversible with an anisotropy field of $H_K = 5.8$ Oe. The form of the torque curves for various fields is described and composed with the theories of Stoner—Wohlfarth, Kondorsky and of Shtrikman and Treves (Abstr. 13783 of 1960). D.J.Oliver

14724 ON THE MAGNETIC PERMEABILITY OF MIXTURES CONTAINING FERROMAGNETIC PARTICLES AND POROUS FERROMAGNETIC MATERIALS.

E.Laurila.

Ann. Acad. Sci. Fennicae A VI (Finland), No. 70, 13 pp. (1961).

A simple model for calculation of the magnetic permeability of mixtures containing ferromagnetic particles is described. The results are in good agreement with experiments made with artificial mixtures of nonmagnetic and ferromagnetic powders. An analogous model for the ferromagnetic properties of porous material is also presented. The influence of the pores is considered, the pores being treated as magnetic dipoles opposite to the field, which thus generate a demagnetizing Lorentz field. Formulae for the inner demagnetizing factor and for the effective permeability are presented.

14725 EXPERIMENTAL STUDY OF MAGNETIC SUSCEPTIBILITY IN THE CASE OF AN ENSEMBLE OF VERY FINE MAGNETIC GRAINS DISPERSED IN A NONMAGNETIC SUBSTANCE.

E.Le Borgne.

Ann. Geophys. (France), Vol. 16, No. 4, 445-94 (1960). In French.

The magnetic susceptibility of some soils is relatively high because these soils contain very fine grains of a neo-formation product belonging to the $\gamma\text{-Fe}_2\text{O}_3$ stabilized type. By means of a magnetometer, measurements of the "viscosity" of the induced magnetization and of the remanent magnetization were made for one of these soils, at room temperature. For weak magnetizing fields and with respect to some time conditions which are precisely stated, the increase of the induced magnetization is equal to the decay of the remanent magnetization when equal and corresponding intervals of time are taken. This equality is forecast by Néel's theory of the magnetic "viscosity" for assemblies of small single-domain particles dispersed in a non magnetic substance. Varying the intensity of the magnetizing field, the time of application, the temperature of the sample when the field is applied, a lot of results are gathered which agree with the theory. Néel's relations are applied to estimate the order of magnitude of the size of the magnetic grains from the experimental data. Soils, which have been previously heated in order to obtain the formation of a product of the Fe_3O_4 type or of the $\gamma\text{-Fe}_2\text{O}_3$ type, according to the baking conditions, were subjected to similar experiments. In both cases, the magnetic grains had the behaviour of single-domain ones; when they had the same size, the magnetic grains appeared to be different, from one type to the other, by the magnitude of their critical field.

14726 TEMPERATURE DEPENDENCE OF THE MAGNETOSTRICTION CONSTANTS OF DILUTE ALUMINIUM IRON.

E.Tatsumoto, K.Kuwahara, H.Kimura and T.Okamoto.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 367-9 (Oct., 1960).

The constants λ_{100} and λ_{111} of 0.66% and 1.32% Al—Fe single crystals were obtained between about 80° and 1000°K; the results resemble those for pure Fe and Si—Fe. E.P.Wohlfarth

14727 THE INFLUENCE OF PLASTIC DEFORMATION ON THE MAGNETOSTRICTION CONSTANT OF NICKEL.

J.Pačes and P.Šuda.

Czech. J. Phys., Vol. 11, No. 6, 439-43 (1961).

The magnetostriction constant of nickel was measured as a function of plastic deformation up to an elongation of 30%. The values of the magnetostriction constant in deformed samples deviate considerably, a fact which cannot be explained by errors of measurement. The absolute value of the magnetostriction constant decreases with increasing plastic deformation (by ~ 5%).

14728 TIME DECREASE OF PERMEABILITY OF SUBSTITUTIONAL FERROMAGNETIC ALLOYS.

C.Kuroda.

J. Phys. Soc. Japan, Vol. 15, No. 10, 1898 (Oct., 1960).

From measurements of decrease of permeability with time by a.c. at various temperatures for 30% Co in Ni, the magnetic aftereffect may be described on the assumption of a logarithmic distribution of relaxation times. The activation energy for the process is about 2.5 eV. C.A.Hogarth

14729 THE EFFECT OF NON-MAGNETIC IMPURITIES OF SUBSTITUTION ON MAGNETIC COUPLINGS IN METALS: APPLICATION TO ELECTRIC RESISTIVITIES.

Y.A.Rocher.

J. Phys. Radium (France), Vol. 22, No. 6, 367-76 (June, 1961). In French.

The presence of non-magnetic impurities in a magnetic metal strongly affects its electrical and magnetic properties. In order to explain these effects, a simple model is studied, in which the of two magnetic atoms are coupled through an intermediate im Within the limits of the molecular-field and classical-spin ap tions, the displacement of the transition temperature, the sha spin correlations at high temperatures and the changes at low temperatures in magnetic structure around an impurity are s and related to the sign and strength of the indirect interaction results are used to calculate the electrical resistivity. The m appears to explain particularly well the properties of Mn—Cu Pu—Al alloys.

14730 ON THE NATURE OF RADIATION DAMAGE DUE FAST NEUTRON BOMBARDMENT IN FERROMAGNETIC MATERIALS: VERY HIGH PERMEABILITY PUR IRON AND NICKEL.

G.Biorci, A.Ferro and G.Montalenti.

Nuovo Cimento (Italy), Vol. 20, No. 4, 617-37 (May 16, 1961).

The effects of fast neutron irradiation with doses of 10^{18} permeability, coercive force and approach to saturation of ve high permeability pure iron and nickel were studied. No signi changes were noted on nickel (maximum permeability 5000). iron (maximum permeability about 150 000, H_c 2.5 A/m) coerc force increased by about 0.8 A/m, maximum permeability decreased by about 30%, and no change was noted in the curve approach to saturation and hence in the anisotropy energy. Af annealing the irradiated iron specimens at 100°C, a further increase of coercive force was observed, and after annealing 200°C, on one of the specimens a loop with strong wasp-waisted was noted. Finally most of the changes in magnetic properties to irradiation were almost completely recovered below 250°C. possible theoretical interpretations of the results are discusse The kinetics of the annealing leads to exclude that the effects a due to free iron interstitials and probably also to dislocations Hence it is thought that these are anisotropic point defects whi interact with the magnetization vector and move with an activa energy of about 1.2 eV at temperatures of (100-200)°C.

14731 EFFECT OF SPIN—SPIN AND SPIN—PHONON INT ACTIONS IN A FERROMAGNETIC ON THE ENER DISTRIBUTION OF SCATTERED NEUTRONS.

V.N.Kashcheev and M.A.Krivoglaz.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1541-52 (May, 1961). In Russian.

The effect of the interactions of elementary perturbations (excitations) on the energy distribution of neutrons, scattered b ferromagnetic is discussed mathematically. The quantities det mined are (a) the peak width and displacement of the peak maxi in the case of one-magnon scattering due to spin—spin and spin—phonon interactions, (b) the peak width in the case of one- phonon scattering and (c) the change in the velocity of the elast waves associated with the interactions of phonons and spin wav The relations connecting displacement and peak width with tempe ture and the wave vector of the elementary perturbation are investigated. [English translation in: Soviet Physics—Solid Stat (USA)]. N

14732 ON THE CRITICAL SCATTERING OF NEUTRONS.

H.Mori and K.Kawasaki.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 723-5 (April, 1961)

An expression for the diffusion constant of spin, used in the description of the inelastic part of the critical scattering of neutrons by a ferromagnetic, is given in terms of the correlatic functions of certain spin operators. This expression is evaluat for iron using the Heisenberg model. J.F.Corn

14733 PARTIAL SWITCHING OF RECTANGULAR HYSTERESIS-LOOP FERRITES.

A.Góral.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 2, 9 (1961).

Measurements were made of changes of magnetization of square-loop ferrites when the magnetizing field pulse was of too short duration to cause complete reversal of the magnetization. The results are displayed in terms of a parameter which is the sum of a term related to the switching coefficient as usually defined and a term attributable to the non-uniformity of the flux reversal process. This parameter is more useful than the swit coefficient since it is not restricted in its application to hystere loops of any particular shape. R.A.Wal

734 TEMPERATURE DEPENDENCES OF THE WIDTH OF THE RESONANCE CURVE AND THE RELAXATION
ESSES IN SINGLE CRYSTALS OF FERRITES.
urevich, I.E.Gubler and A.G.Titova.
verdogo Tela (USSR), Vol. 3, No. 1, 19-31 (Jan., 1961).
ssian.
or abstract, see Abstr. 12537 of 1961. [English translation
oviet Physics - Solid State (USA), Vol. 3, No. 1, 13-22
1961)].

735 MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF HEXAGONAL BARIUM MONO-FERRITE,
Fe_2O_3. C.Okazaki, S.Mori and F.Nanamaru.
ys. Soc. Japan, Vol. 16, No. 1, 119 (Jan., 1961).
usceptibility at room temperature is 7.6×10^{-6} e.m.u./g, and
mperature variation indicates antiferromagnetism. From
y single-crystal photographs the unit cell is hexagonal with
.44 A, a = small integral multiple of 5.51 A. A.R.Stokes

4736 THE ESTIMATION OF DOMAIN WALL VELOCITY IN A "SQUARE LOOP" FERRITE, AND SOME OBSERVATIONS
THE REVERSAL PROCESS. J.E.Knowles.
. Phys. Soc. (GB), Vol. 78, Pt 2, 233-8 (Aug., 1961).
Bitter pattern observations were used to investigate the relation-
between the applied field and wall velocity in a polycrystalline
ganese—magnesium ferrite. The wall velocity was found to lie
ie range 500 to 1000 cm sec^{-1} (effective $Oe)^{-1}$ and the motion
ie wall was shown to be impeded by Néel spike domain structures
nd pores in the material. The quasi-static nucleation and
rsal process was also investigated: it was found that after
ration,nuclei of reverse magnetization appeared on pores on the
n boundary, which evolved into trapezoidal domain structures.
leation appeared to play no part in the low field (±3 Oe) reversal
ess.

.4737 EXPERIMENTAL STUDIES OF THE PROPERTIES OF CERTAIN FERRITES IN THE 10 kMc/s RANGE.
agan.
. Phys. (France), Vol. 5, No. 9-10, 1301-54 (Sept.-Oct., 1960).
rench.
Deals with measurements at low power, mainly on manganese
nickel—zinc ferrites in which the iron is replaced by up to 20%
omium. Details are given of experimental technique, and
isurements made, on ferrite rods in cylindrical waveguides, over
mperature range from −100°C to +100°C, of Faraday rotation,
rtion loss, and ellipticity. The value of the polarizing magnetic
d at resonance was determined, and found to decrease with
easing percentage of chromium, contrary to expectations based
in existing theory of the decrease of loss as the magnetization
reases. It is suggested instead that the effect is due to a decrease
he imaginary part of the dielectric constant of the ferrite. The
ond part of the paper gives details of measurement of Landé
itting factor and dielectric constant made on a spherical sample
resonant cavity. The effects of sample size and of the size of
coupling hole are discussed. It is suggested that better values
can be obtained by the use of single-crystal samples. In this
ie, the orientation of the sample with respect to the crystallo-
phic axes is determined from observations of ferromagnetic
onance, and this also enables the first-order anisotropy constant
e determined. The dielectric constant was studied as a function
temperature from −150°C to +100°C. R.A.Waldron

14738 THE DISTRIBUTION OF IONS AND THEIR VALENCIES IN MAGNESIUM MANGANESE FERRITES. J.Brož.
ech. J. Phys., Vol. 10, No. 6, 428-38 (1960).
A model of the distribution of cations and valencies in non-
ichiometric magnesium manganese ferrites is proposed and its
idity verified by measuring the saturation magnetic moments.
e results of measuring the moment in stoichiometric ferrites to
ertain extent confirms the correctness of the proposed model for
s type of magnesium manganese ferrite, too. In a discussion of
distribution coefficient for manganese ions the close connection
tween this coefficient and the average valency of the manganese
s pointed out. The question of the dependence of the distribution
efficient of magnesium ions on the composition is solved by
roducing the maximum values of this coefficient and assuming
it a simple proportionality hold for all compositions between the
tual value of this coefficient and its maximum value.

14739 STUDY OF MAGNETIC AFTER-EFFECT IN MAGNESIUM MANGANESE FERRITES. S.Krupička.
Czech. J. Phys., Vol. 10, No. 11, 782-810 (1961).

The magnetic after-effect caused by the diffusion of electrons was studied in detail in MnMg ferrites of the series $Mg_xMn_{1.15-x}Fe_{1.85}O_{4+\gamma}$; the comparative measurements were also carried out on a sample of $MgFe_2O_{4+\gamma}$ ($\gamma < 0$). By combining the two methods, (a) investigation of the disaccommodation of initial permeability at different temperatures and (b) measurement of the displacement of the maximum of the temperature dependence tan δ with the frequency, it was possible to study the relaxation processes whose time constants lay between 0.5 sec and several hours, or between 10^{-4} to 10^{-7} sec. It was found that the processes taking place at low temperatures and studied by method (a) differ from those observed at high temperatures by method (b), particularly in lower activation energies and greater dispersion of the time constants. In addition to these two main relaxation processes a weak relaxation superposed over the main disaccommodation was found in ferrites with non-zero content of manganese. An analysis of the intensity of different relaxation effects showed the participation of Mn ions in these relaxation effects and it was found that both main relaxations are probably equivalent as regards the final steady-state, to the creation of which they lead; they differ however in the mechanism of electron diffusion by which this state is realized. The main features of the different diffusion mechanisms are discussed.

14740 TEMPERATURE DEPENDENCE AND TIME VARIATION OF THE INITIAL PERMEABILITY IN MANGANESE—ZINC—Fe^{2+} FERRITES. J.T.Verschoor.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960), p. 204-9. In German.

The time variation of the initial permeability of Mn—Zn—Fe^{2+} ferrites has a connection with 180°-wall displacements. The mechanism of variation in the first 100 seconds after demagnetization appears to be different from that prevailing at later instants. It is suggested that the Néel type thermal after-effect may be involved. Besides the primary maximum at the Curie point the permeability shows a secondary maximum at a lower temperature. No relation between the magnitude and the position of the maximum with the time variation is evident. The secondary maximum in Mn—Zn—Fe^{2+} ferrites with different Fe_2O_3 contents is displaced towards lower temperatures as the iron oxide content increases. The temperature dependence of the initial permeability agrees with that of the magnetostriction constant λ_s for the same mol.% Fe_2O_3. In order to elucidate the cause of the time variation and the temperature dependence of the initial permeability a thorough analysis of the influence of the 180°-wall is necessary. D.S.Parasnis

14741 THE TEMPERATURE DEPENDENCE OF THE INITIAL PERMEABILITY OF HIGH PERMEABILITY MANGANESE—ZINC FERRITES. E.Röss and E.Moser.
Z. angew. Phys. (Germany), Vol. 13, No. 5, 247-50 (May, 1961).
In German.

In these ferrites there occur subsidiary maxima in the initial permeability which are hitherto unexplained, quite apart from the maximum near the Curie temperature. These subsidiary maxima are composition-dependent and generally occur above −80°C, and can for certain compositions merge with the Curie point maxima. Ferrites have been prepared with initial permeabilities in the range from 2000 to 10 000. R.Parker

14742 MAGNETIC SPECTRA OF A MIXED NICKEL, ZINC AND COPPER FERRITE IN THE STATE OF REMANENT MAGNETIZATION AT VARIOUS TEMPERATURES. L.A.Fomenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 132-41 (Jan., 1961).
In Russian.

Reports a study of the temperature dependence (−80 to +232°C) of the magnetic spectra (dependence of permeability on frequency) of a NiZnCu ferrite (sintered at 1140°C,Curie temperature 238°C). The spectra were obtained with the ferrites in the demagnetized and magnetized states. At the highest test temperatures, the dispersion was due to diffusion processes; at other temperatures, domain wall motion was important and predominated at temperatures from −80 to +100°C. The resonances were ascribed to Dering-type motion of the domain walls. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 95-101 (July, 1961)]. A.Tybulewicz

14743 ON SOME CALCIUM—IRON—OXYGEN COMPOUNDS.
P.B.Braun and W.Kwestroo.

Philips Res. Rep. (Netherlands), Vol. 15, No. 4, 394-7 (Aug., 1960).

Three new calcium oxide—iron oxide compounds were stabilized by addition of small amounts of a third component:

(α) $Ca_4Fe_{14}O_{25}$, hexagonal (R$\bar{3}$c) with a = 6.0 A and c = 95.0 A. Stabilized by, e.g., Y^{3+}. Ferrimagnetic, preferential plane of magnetization.

(β) $Ca_4Fe_{14}O_{25}$, hexagonal (P$\bar{3}$c) with a = 6.0 A and c = 31.6 A. Stabilized by, e.g., Mg^{2+}.

(γ) $Ca_4Fe^{2+}{}_2Fe^{3+}{}_{18}O_{33}$, hexagonal (R$\bar{3}$c) with a = 6.0 A and c = 62.3 A, also stabilized by, e.g., Mg^{2+} ions. Ferrimagnetic, preferential plane of magnetization.

Magnetic properties and X-ray data are given.

14744 THEORY OF INDIRECT EXCHANGE INTERACTION IN SPINEL-LIKE SYSTEMS. K.P.Sinha.

Indian J. Phys., Vol. 35, No. 3, 111-27 (March, 1961).

A theoretical study is made of the indirect exchange interaction for the spin coupling in spinel-type magnetic compounds. Detailed calculations are carried out for the elementary, four-centre ($A—O—B_2$; A and B represent the cations and O denotes the anion) and five-electron system. This furnishes the appropriate model for describing both A—B and B—B types of interactions. The relative energies of the ferromagnetic (quartet Q) and the two ferrimagnetic (doublets D_1 and D_2) states are assessed for the above model. It is shown that, within the framework of the present mechanism, the ferrimagnetic state D_1, which represents antiparallel spins in A-B and parallel in B-B, is the most stable state. This is in agreement with the observed situation.

14745 MAGNETIC FIELD AT THE NUCLEUS IN SPINEL-TYPE CRYSTALS.

W.H.Kelly, V.J.Folen, M.Hass, W.N.Schreiner and G.B.Beard.

Phys. Rev. (USA), Vol. 124, No. 1, 80-4 (Oct. 1, 1961).

Measurements of the magnetic field at the Fe^{57}nucleus were obtained on powder samples at room temperature using the Mössbauer effect for the spinel-type ferrites γ-Fe_2O_3, "ordered" lithium ferrite ($Li_{0.5}Fe_{2.5}O_4$), and "disordered" lithium ferrite giving values of |496 ± 20|kOe., |508 ± 20|KOe., and |510 ± 20| kOe. These compounds contain only trivalent and no divalent iron. The Mössbauer spectra of all of these compounds were very similar and no difference could be detected between the "ordered" and "disordered" compounds. Only one set of lines was observed indicating that the fields at the octahedral and tetrahedral sites are about the same value. The value of the hyperfine interaction constant A obtained from electron paramagnetic resonance spectrum of the divalent Mn^{55} (isoelectronic with trivalent Fe) impurity in single crystals of the isomorphous spinel-type crystal "disordered" lithium aluminate ($Li_{0.5}Al_{2.5}O_4$) was found to be $|77.2 \pm 1.0| \times 10^{-4}$ cm^{-1}. The angular variation of the spectrum indicated that the divalent Mn^{55} ions were located substantially on octahedral sites. The corresponding magnetic field for the Mn^{55} nucleus is around 550 kOe, which is close to the value obtained elsewhere for the Mn^{55} nucleus located on a tetrahedral site in a spinel-type aluminate. This is in good agreement with the Mössbauer results.

14746 SUSCEPTIBILITY OF GADOLINIUM IRON GARNET BELOW THE NÉEL POINT. W.P.Wolf and R.M.Bozorth.

Phys. Rev. (USA), Vol. 124, No. 2, 449-52 (Oct. 15, 1961).

Measurements of the spontaneous magnetization and the superposed paramagnetic susceptibility of gadolinium iron garnet were repeated with a specimen of good stoichiometry, in the range of 2° to 300°K. It is concluded that the effective field which the Fe sublattices exert on the Gd ions causes paramagnetic saturation and consequently a reduction in susceptibility of the Gd sublattice. Good qualitative agreement is obtained by using molecular field theory without any adjustable constants, and in contrast to earlier interpretations, it is found necessary to postulate appreciable antiferromagnetic interactions between the Gd ions.

14747 COMMENT ON THE SATURATION MAGNETIZATION OF NEODYMIUM YTTRIUM IRON GARNET.

R.L.White.

J. appl. Phys. (USA), Vol. 32, No. 6, 1178-9 (June, 1961).

The author points out that the increase in saturation magnetization of yttrium iron garnet observed when neodymium is subst
for yttrium is to be expected in principle for all rare earth io
having less than a half-filled 4f shell. Such increase is not ob
served for Sm and Eu and it is shown that these are special ca
not inconsistent with the general principle. The exchange fiel
acting on the Nd ions is calculated to be 360 kG which is simil
that acting on other comparable rare earth ions. F.E.

14748 MAGNETOSTRICTION OF YTTRIUM IRON GARNE
A.Nakamura and Y.Sugiura.

J. Phys. Soc. Japan, Vol. 15, No. 9, 1704 (Sept., 1960).

An adhesive strain gauge was used for measurements at r
temperature. The result of (3.7 ± 0.5) × 10^{-7} for the saturatio
magnetostriction constant agrees with a rough theoretical exti
The small value is explained by the dipolar interaction.
C.A.Ho

14749 CURIE TEMPERATURE OF SOME GARNETS BY DIFFERENTIAL THERMAL ANALYSIS TECHNIQU

A.Aharoni, E.H.Frei, Z.Scheidlinger and M.Schieber.

J. appl. Phys. (USA), Vol. 32, No. 10, 1851-3 (Oct., 1961).

The differential thermal analysis (DTA) technique was use
measure the Curie temperature of yttrium—iron garnets, and
garnets obtained by partially substituting Sm, Nd, Pr, or La fo
Y. The accuracy of the method is within about 1 deg C. It is f
that in all the above substitutions the Curie point increases mo
or less linearly with the rare-earth content, the slope being
largest for Pr and somewhat less for Nd and Sm. For La, only
compound $Y_{2.5}La_{0.5}Fe_5O_{12}$ could be prepared and the Curie poin
did not show any measurable change from that of pure yttrium-
garnet. Two possible explanation are suggested for the increas
in Curie point on Sm substitution, which does not change the
magnetization of the garnet.

14750 THE PROPERTIES OF MIXED YTTRIUM—HOLMIU GARNETS. A.Vassiliev, J.Nicolas and M.Hildebra

C.R. Acad. Sci. (France), Vol. 253, No. 2, 242-4 (July 10, 1961)

In French.

The saturation moments of garnets having the general for
$3[(1-x)Y_2O_3.xHo_2O_3]\ 5Fe_2O_3$ were measured as a function of
temperature. The Curie temperatures and compensation points
deduced. The value of the moment for x = 0, extrapolated to 0°
in excellent agreement with the theoretical value of 10 μ_B. Effe
g values and line breadths were measured at 9535 Mc/s. The
results are discussed. S.A.

14751 MICROWAVE HARMONIC GENERATION BY FERRIMAGNETIC CRYSTALS.

D.D.Douthett, I.Kaufman and A.S.Risley.

J. appl. Phys. (USA), Vol. 32, No. 10, 1905-12 (Oct., 1961).

The experimental behaviour of isotropic ferrimagnetic ins
tors in second harmonic generation at microwave frequencies
investigated and compared with the behaviour predicted by the
equations of motion with Landau—Lifshitz and with Bloch—Bloembergen damping. In general, a close agreement between
experiment and theory was found. The experiments were carri
out with small samples of single-crystal manganese ferrite, Y
and other ferrimagnetic materials. Since harmonic generation
is caused by asymmetries in the precessional orbit, measurem
were made with disk-shaped specimens in which the demagneti
fields create the asymmetry. The technique employed a cavity
simultaneously resonant to 8.5 and 17 kMc/s. Absolute values
field intensities and magnetizations were computed from absol
power measurements. A figure of merit F for a ferrimagnet i
defined. In a practical 2ω generator the output power $P_{2\omega}$ is
expected to vary as the product $F^2P_i^{\,2}$, where P_i is the input ω
In comparing materials at ferrimagnetic resonance F should v
as χ_0''. This was verified experimentally, even at high drive le
At constant frequency and drive level F should be nearly indepe
ent of H_{dc}. Only slight deviations from this were found at low
drive levels.

14752 FERRIMAGNETISM.
W.P.Wolf.

Rep. Progr. Phys. (GB), Vol. 24, 212-303 (1961).

This is a review of the physical properties of ferrimagneti
materials. These are substances which exhibit spontaneous
magnetization due to non-parallel alignment of their atomic
magnetic moments, and which at the same time are generally p

ictors of electricity. Some of their characteristic properties
from the multidirectional alignment, while others arise from
ict that it is possible to carry out experiments at very high
encies without interference from eddy currents. Due to the
derable difficulties in preparing suitable samples, detailed
rstanding of many properties has only recently become possible,
. large number of "spurious" effects have been detected in
er measurements. This review will therefore concentrate on
inds of experiments and theories which have been developed,
r than a summary of individual results.

MAGNETIC PROPERTIES OF CHROMIUM SULPHIDES.
Abstr. 14465

1753 THERMAL VARIATION OF THE PITCH OF HELICAL SPIN CONFIGURATIONS. M.J.Freiser.

;. Rev. (USA), Vol. 123, No. 6, 2003-12 (Sept. 15, 1961).

When the method of Luttinger and Tisza (Abstr. 1043 of 1947)
inding the classical ground state of a system of spins in anti-
omagnetics with Heisenberg interactions is applicable, it yields
nfiguration with the same periodicity as the ordered state
ting just below the transition temperature. When the method
uttinger and Tisza fails to yield the classical ground state
there can occur, with decreasing temperature, either
tional transitions or a gradual change in the periodicity of the
le configuration. An example of the latter is the thermal change
tch of a helical configuration. Such a situation can be described
e internal field approximation when the consistency equations
it as solutions helical states with a continuous range of pitches.
free energy of the stable state with a temperature-dependent
1 can then be obtained as the envelope of the free-energy curves
nging to the family of helical solutions. A one-dimensional
omic chain whose ground state can be found by a generalization
ie method of Luttinger and Tisza illustrates this possibility.
also pointed out that anisotropic exchange interaction between
est neighbours can give rise to helically ordered configurations.

4754 INFLUENCE OF NEXT NEAREST NEIGHBOURS ON THE SUPERSTRUCTURAL ANISOTROPY OF SPIN-
/E DISPERSION. H.Cofta.

ι phys. Polon. (Poland), Vol. 19, No. 3, 405-7 (1960). In German.

A more accurate presentation is given for work described
ier (Abstr. 11904 of 1960) by including next nearest neighbours
using a more detailed equation. Nearest neighbours give a
iounced anisotropy but next nearest neighbours produce an
ropic dispersion formula. J.A.Bornmann

.4755 ANTIFERROMAGNETIC SUSCEPTIBILITY OF THE PLANE TRIANGULAR ISING LATTICE.

'.Sykes and I.J.Zucker.

's. Rev. (USA), Vol. 124, No. 2, 410-14 (Oct. 15, 1961).

The magnetic moment transformation developed by Fisher
str. 5875 of 1959) enables the antiferromagnetic susceptibility
he plane trangular Ising lattice to be expanded as a power series
: converges over the whole temperature range $0 \leq T \leq \infty$. The
iinant asymptotic behaviour of the coefficients conjectured from
rapolations by Domb and Sykes (Abstr. 6264 of 1961), and inde-
dently by Park, has been established theoretically by Fisher. A
nting theorem based on the method of Oguchi (1951) enables the
st twelve terms of the expansion to be derived. It is found
sible to evaluate the susceptibility numerically over the whole
ıperature range with a maximum error of 0.1% at $T = 0$. It is
cluded that the specific susceptibility per spin $(kT\chi_0/m^2)$ falls
oothly from unity at $T = \infty$ to a value at $T = 0$ which does not
er by more than 0.1% from 5/36, and the form of the counting
orem leads it to be surmised that it is exactly 5/36.

14756 SUPERSTRUCTURAL ANISOTROPY OF THE SPIN WAVE DISPERSION IN ANTIFERROMAGNETICS.
THEORY. H.Cofta.

:a phys. Polon. (Poland), Vol. 20, No. 7, 591-612 (1961).

In a previous paper (Abstr. 14664 of 1961), the author pre-
ited purely geometrical hypotheses about the anisotropic propa-
ion of spin waves in regular antiferromagnetic superstructures.
the present paper theoretical proofs of these hypotheses are
en. The general dispersion law for long spin waves is derived
a tensor form, starting from Ziman's relation (Abstr. 6617 of
52) based on the Holstein—Primakoff approximation. The
mulae for all 7 regular superstructures are obtained, valid for
itrary values J_n and J_s of exchange integrals between nearest and next nearest neighbours, respectively. For the extreme cases ($J_n = 0$ or $J_s = 0$), the dispersion anisotropy caused by the superstructure appears to be very pronounced, in full agreement with aforementioned hypotheses. For the more realistic non-zero values of exchange integrals, the anisotropy is also evident but depends on the ratio J_n/J_s. The theoretical treatment leads to the prediction of a new phenomenon in antiferromagnetics: the anisotropic spin wave dispersion which must be attributed to the monoplanar, as well as to the biplanar, type of regular superstructure. It is shown that the magnetic anisotropy does not affect in principle the phenomeno under consideration. The possibility of the occurence of analogous phenomena in other latttics and superstructures is discussed.

14757 SUPERPOSITION OF ANTIFERROMAGNETISM AND SUPERPARAMAGNETISM IN A VERY SMALL GRAIN.

L.Néel.

C.R. Acad. Sci. (France), Vol. 253, No. 1, 9-11 (July 3, 1961).
In French.

The average magnetic moment is calculated of a very small grain of permanently magnetized antiferromagnetic material placed in a magnetic field. It is assumed that the variation with orientation of the energy of coupling of the direction of the antiferromagnetism with the crystal lattice is negligible in comparison with the energy of thermal agitation. R.A.Waldron

14758 ANTIFERROMAGNETIC MAGNETOSTRICTION IN CoO AND NiO SINGLE CRYSTALS.

T.Nakamichi and M.Yamamoto.

J. Phys. Soc. Japan, Vol. 16, No. 1, 126-7 (Jan., 1961).

Measurements were made at room temperature and at liquid nitrogen temperature on plates coinciding with the (100) plane. Roughly, $\lambda \propto H^2$. The magnetostriction arises from the displacements of the antiferromagnetic domain walls. D.J.Oliver

14759 MAGNETIC PROPERTY OF Cr_2O_5.

E.Hirota and B.Kubota.

J. Phys. Soc. Japan, Vol. 15, No. 9, 1715 (Sept., 1960).

The susceptibility follows the law $\chi = C/(T + \Theta)$ with $C = 8.44 \times 10^{-3}$ e.m.u. $(g\ deg)^{-1}$ and Θ ν 140°K. D.J.Oliver

14760 MAGNETIC AND ELECTRICAL PROPERTIES OF IRON SULFIDE SINGLE CRYSTALS. T.Hihara.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 1, 31-53 (July, 1960).

Crystals of composition FeS_x with $1.00 \leq x \leq 1.14$ were investigated between liquid nitrogen temperature and 450°C. For $x \leq 1.04$ the easy direction of antiferromagnetic spins turns from the c-axis to the c plane at a particular temperature T_α which is also the temperature at which the exchange constant decreases abruptly. T_α decreases from 138°C to 115°C whilst x increases to 1.04. When $x = 1.05$ the exchange constant changes at $T_\alpha = 110°C$ whilst the easy direction alters at $T_\alpha' = -30°C$. T_α' decreases with x increasing. For $x \geq 1.07$ a similar transformation occurs at a higher temperature T_γ (150°C-210°C); as x increases this manifests itself firstly as a peak in the susceptibility and ultimately as a spontaneous ferrimagnetism. Iron sulphides are p-type semiconductors and the conductivities show anomalies at T_α and at the Néel temperature but not at T_α' or T_γ. It is concluded that the conduction depends essentially on the bonding nature or the axial ratio c/a. D.J.Oliver

14761 ANTIFERROMAGNETISM OF $FeSn_2$.

K.Kanematsu, K.Yasukōchi and T.Ohoyama.

J. Phys. Soc. Japan, Vol. 15, No. 12. 2358 (Dec., 1960).

$FeSn_2$ is antiferromagnetic according to the authors' experiments on sintered specimens with lattice constants a = 6.50 A, c = 5.31 A and c/a = 0.816. The antiferromagnetic Néel point is 380°K. The Curie—Weiss law holds above 500°K, the effective magnetic moment per iron atom is 3.36 μ_B and the asymptotic Curie temperature −230°K. Magnetic measurements on $MnSn_2$, $FeGe_2$ and $CoSn_2$ show that the first compound is antiferromagnetic the second parasitic ferromagnetic and the third weakly paramagnetic.
D.S.Parasnis

14762 SPIN WAVES IN MnF_2 AND THE INELASTIC SCATTERING OF NEUTRONS. O.Nagai and A.Yoshimori.

Progr. theor. Phys. (Japan), Vol. 25, No. 4, 595-602 (April, 1961).

The spin wave dispersion relation for MnF_2 is studied for various assumed values of the ratio of the exchange coupling constants J_2 to

J_1. The inelastic scattering cross-section of neutrons by spin waves in this crystal is also calculated, and, particularly, using the value of $J_2 = 1.08\,J_1$, which seems to be supported experimentally, distinctive features of the scattering cross-section are discussed.

14763 HELICOIDAL ANTIFERROMAGNETISM OF $MnAu_2$ STUDIED BY NEUTRON DIFFRACTION.

A.Herpin and P.Meriel.
J. Phys. Radium (France), Vol. 22, No. 6, 337-48 (June, 1961).
In French.

It is shown that the tetragonal centred structure of $MnAu_2$ can be considered as layers of manganese packed normally to the c axis, separated by two layers of gold. $MnAu_2$ is helimagnetic: all atoms of manganese in the same layer have their moments parallel to each other and normal to the c axis, these moments turning by a constant angle when passing from one layer to the next. A magnetic field parallel to c has little influence on this magnetic structure, but a field normal to c modifies it abruptly as soon as it exceeds a threshold of 9.6 kOe. A theory, taking into account exchange interactions between atoms of first and second neighbouring layers, quantitatively accounts for all the observed properties of this alloy.

14764 MAGNETIC PROPERTIES OF INTERMETALLIC COMPOUNDS IN MANGANESE—TIN SYSTEM: $Mn_{3.67}Sn$, $Mn_{1.77}Sn$, and $MnSn_2$.

K.Yasukōchi, K.Kanematsu and T.Ohoyama.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1123-30 (June, 1961).

In $Mn_{3.67}Sn$, an anomalous magnetic phenomenon was found, which may be due to its antiferromagnetism. The Néel temperature T_N, the effective number of Bohr magnetons per Mn n_p, and the asymptotic Curie point θ_a are 365°K, 3.58, and -275°K, respectively. $Mn_{1.77}Sn$ is ferrimagnetic. The estimated saturation magnetization per Mn at 0°K, $n_f\mu_B$, as well as n_p and the Curie temperature T_C, were determined after various heat treatments. With lowering the annealing temperature, T_C was increased from 226° to 263°K, and n_f was increased from 0.92 to 1.23, while n_p stayed nearly constant at about 3.4. These behaviours are interpreted in terms of the effect of atomic ordering. It was also found that $MnSn_2$ exhibited and antiferromagnetic behaviour. T_N, θ_a, and n_p are 324°K, +190°K, and 3.48, respectively.

14765 THE MAGNETIC INVESTIGATION OF Mn^{++}, Co^{++}, Ni^{++} AND Cu^{++} AMMINE AND ANHYDRATE SALTS AT LOW TEMPERATURES. T.Watanabe.

J. Phys. Soc. Japan, Vol. 16, No. 6, 1131-41 (June, 1961).

The magnetic susceptibility measurements of ammine salts and anhydrate salts of Mn^{++}, Co^{++}, Ni^{++} and Cu^{++} ions at the temperature above 90°K have been carried out previously by Kido and the present author (Abstr. 21027 of 1960). The magnetic susceptibilities of these salts show no deviation from the Curie—Weiss law down to 90°K. The results for magnetic susceptibility measurements of these salts at liquid helium and liquid hydrogen temperatures are given in the present report. The susceptibility measurements were carried out by the Hartshon bridge method. The salts which were studied are $Mn(NH_3)_6Cl_2$, $Mn(NH_3)_2Cl_2$, $Mn(NH_3)Cl_2$, $MnCl_2$, $Co(NH_3)_6Cl_2$, $Co(NH_3)_2Cl_2$, $Co(NH_3)Cl_2$, $CoCl_2$, $Ni(NH_3)_6{\cdot}Cl_2$, $Ni(NH_3)_6(ClO_4)_2$, $Ni(NH_3)_2Cl_2$, $Ni(NH_3)Cl_2$, $NiCl_2$, $Cu(NH_3)_4SO_4{\cdot}H_2O$, $Cu(NH_3)_2SO_4$ and $CuSO_4$. The antiferromagnetic or metamagnetic behaviour in all other salts except $Mn(NH_3)_6Cl_2$, $Mn(NH_3)_2Cl_2$, $Co(NH_3)_2Cl_2$, $Ni(NH_3)_6Cl_2$, $Ni(NH_3)_6(ClO_4)_2$ and $Cu(NH_3)_2SO_4$ was found in the temperature range from 1.5°K to 20.4°K. The magnitude of the Weiss temperatures θ is largest for Ni^{++} and smallest for Mn^{++} in each coordinated salt of $M(NH_3)_6Cl_2$, $M(NH_3)_2Cl_2$, $M(NH_3)Cl_2$ and MCl_2 (M is one of Mn^{++}, Co^{++}, and Ni^{++} ions). The unexpected results are found in the case of $Ni(NH_3)_6Cl_2$ and $Ni(NH_3)_6(ClO_4)_2$, as compared with the results of n.m.r. by Kim and Sugawara (Abstr. 535 of 1960).

Magnetic Resonances

14766 THE RESONANCE FREQUENCY SPECTRUM OF A FERROMAGNETIC METAL. Yu.A.Izyumov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 662-6 (May, 1960). In Russian.

An analysis is presented based on the s—d exchange model of Vonsovsky [Zh. eksper. teor. Fiz. (USSR), Vol. 16, 981 (1946)], of the equations of motion for the integrated spin of s- and d-electrons, and the natural frequencies of the oscillations of the intensity the magnetization vector in a ferromagnetic transition metal determined. When the G-factors for s- and d-electrons are t same, two such frequencies are possible, one of which is equa the Larmor precession frequency, the other being shifted tow the infrared region through a distance proportional to the s— exchange integral. M.H.

14767 FERROMAGNETIC RESONANCE IN THIN MAGNE FILMS AT RADIO FREQUENCIES.

T.E.Hasty and L.J.Boudreaux.
J. appl. Phys. (USA), Vol. 32, No. 10, 1807-10 (Oct., 1961).

Ferromagnetic resonance in thin films was extended to th radio-frequency region of from 1-20 Mc/s. Theoretical expre governing this resonance condition are given along with exper al results. It is found that resonance in this region affords an excellent means of measuring the anisotropy field H_k. Films compositions near 80% Fe—20% Ni were studied by this techni The anisotropy field of these films was found to be around 5 O The width of the absorption line varied from 0.6 to 2.4 Oe, dep ing on the composition of the film. The minimum linewidth wa found to occur for the composition of minimum magnetostricti

MICROWAVE FARADAY EFFECT IN FERRITES AT FERROMAGNETIC RESONANCE. See Abstr. 14587

14768 SPIN WAVE RESONANCE IN Cu—Ni ALLOY FILM

H.Nosé.
J. Phys. Soc. Japan, Vol. 16, No. 2, 342 (Feb., 1961).

Spin wave resonance in Cu—Ni films of nearly perfect str was studied at 9300 Mc/s. The values of the exchange coupling constant A decreased rapidly in inverse proportion to the conc tration of Cu. A behaves similarly to the Curie temperature, was however measured for a bulk specimen by Marian (1937).
D.S.Par

14769 FERROMAGNETIC RESONANCE IN AN Fe--Ni AL IN THE FORM OF THIN FILMS.

A.Van Itterbeek, J.Smits, G.Forrez and J.Witters.
J. Phys. Radium (France), Vol. 22, No. 1, 19-22 (Jan., 1961).
In French.

A microwave spectrometer was used to study (Abstr. 7777 1961) the ferromagnetic resonance of films obtained by vacuum ev oration of permalloy C on a glass support. The g-factor and the ind ion were calculated from the measurements. The influence of annealing on the following factors was studied: the line shape, value of the resonance field and the value of the induction.

14770 FERROMAGNETIC RESONANCE ABSORPTION OF SINGLE-CRYSTAL THIN FILMS OF NICKEL.

M.Kuriyama, H.Yamanouchi and S.Hosoya.
J. Phys. Soc. Japan, Vol. 16, No. 4, 701-6 (April, 1961).

Single-crystal thin films of Ni having the (100) and the (111 orientations were epitaxially grown by deposition in vacuum on heated rock salt and zincblende. By electron diffraction, these were found to be 100 A to 500 A sized crystallites without appre able strain. By ferromagnetic resonance absorption experimen room temperature, three magnetic quantities were measured at same time: the saturation magnetization, the crystalline aniso and the Landé splitting factor. The first quantity was found to almost independent of the thickness of films (100 A to 1000 A) a its magnitude was 350 or 400 G, respectively for the (111) or th (100) orientation. This difference may be ascribed to the stres films. The second one varied in the range between -2×10^4 an -5×10^4 erg cm^{-3} and the third was 2.2 in average. The crystal anisotropy causes the shift of resonance line as the film is rota its plane. Besides, it was found that the more perfect orientati film has, the narrower is the resonance line.

14771 SPIN WAVE RESONANCE IN Ni FILMS.

H.Nosé.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1714-15 (Sept., 1960).

Spin-wave resonance was observed in 2000 - 2500 A Ni fil evaporated on glass maintained at room temperature. On annea at 100 - 300°C the spin-wave resonance disappeared. C.J.

14772 SPIN WAVE RESONANCE IN Pd—Ni ALLOY FILM

H.Nosé.
J. Phys. Soc. Japan, Vol. 16, No. 4, 838 (April, 1961).

The films were prepared by evaporating processes and on diffraction showed the lattice constants to be in good ment with those obtained from bulk material. The exchange ng constants, A, decreased monotonically with increasing ncentration; g factors were evaluated. The relation of the ion of A to that of T_C, the Curie temperature, is similar to ound for Cu—Ni alloys and it is presumed that A found for films is the same as for bulk material although no data for arison are available. F.E.Hoare

773 ON THE QUESTION OF THE ANOMALOUS INCREASE IN THE LINE WIDTH OF FERROMAGNETIC NANCE ABSORPTION IN FERRITES NEAR THE CURIE T. K.P.Belov and V.F.Belov.
tverdogo Tela (USSR), Vol. 3, No. 5, 1425-7 (May, 1961).
ssian.

n single crystals of Mn, and Mg—Mn ferrites near the Curie there is observed a sharp increase in the line width of magnetic resonance absorption, at a frequency of 9470 Mc/s. at temperature region there also occurs in these substances omalous increase in the coercive force, measured in a tant magnetic field. The hypothesis is suggested that both phenomena are due to one and the same cause, viz. the setting a "magneto-heterogeneous" state in the neighbourhood of the e point. [English translation in: Soviet Physics—Solid State)]. N.Davy

774 INFLUENCE OF EXCESS MANGANESE IONS ON THE ANISOTROPY OF FERROMAGNETIC RESONANCE IN LE CRYSTALS OF MANGANESE FERRITES. V.F.Belov.
tallografiya (USSR), Vol. 5, No. 6, 912-16 (Nov.-Dec., 1960).
ssian.

A description is given of a method of studying ferromagnetic nance in ferrite single crystals, and a new method of orienting errite spheres used in the measurements. The results are n of measurements of the parameters of ferromagnetic reson- in single crystals of manganese ferrites with different contents xcess manganese ions. The magnetic anisotropy constant, g- r, width of absorption resonance line, and resonance field ease with increase in the Mn_3O_4 content of the manganese ferrite. lish translation in: Soviet Physics—Crystallography (USA), 5, No. 6, 868-72 (May-June, 1961)].

4775 TEMPERATURE DEPENDENCE OF THE LINE WIDTH OF FERRIMAGNETIC RESONANCE IN YCRYSTALLINE NICKEL CADMIUM FERRITE. S.Takemoto.
hys. Soc. Japan, Vol. 16, No. 2, 344 (Feb., 1961).

Measurements were made from −180°C to 100°C at 9500 Mc/s 24000 Mc/s. The g-value varies from 2.13 at −180°C to 2.03 00°C. The line width reduces from 400 Oe at −180°C to about Oe at 100°C and increases as the frequency decreases. D.J.Oliver

4776 FERROMAGNETIC RESONANCE [PARAMETERS] IN MONOCRYSTALS OF YTTRIUM FERRITE AT MPERATURES UP TO THE CURIE POINT.
.Belov, V.F.Belov and V.A.Timofeeva.
stallografiya (USSR), Vol. 5, No. 5, 732-6 (Sept.-Oct., 1960).
ussian.

The magnetic anisotropy constant K_1 decreases as the tempera- increases, but g shows hardly any change; the line width ΔH decreases, except near the Curie point, where it increases. The width is examined as a function of the surface treatment given he crystal. [English translation in: Soviet Physics—Crystallo- phy (USA), Vol. 5, No. 5, 699-702 (March-April, 1961)].

14777 LOW-TEMPERATURE FERROMAGNETIC RELAXATION IN YTTRIUM IRON GARNET.
.Spencer, R.C.LeCraw and R.C.Linares, Jr.
ys. Rev. (USA), Vol. 123, No. 6, 1937-8 (Sept. 15, 1961).

The ferromagnetic spin—lattice relaxation time, τ_0, was ained from 4.2° to 300°K in single-crystal yttrium iron garnet which considerable care was taken to reduce both the extraneous re-earth and ferrous impurity ions. The measurements are own to be indicative of the purely ferric ion lattice at temper- res considerably lower than previously attained. A new feature ought out in these data is the observation that below approxi- tely 150°K, τ_0^{-1} versus T is steeper than proportional to T, ich implies an extremely low value at 4.2°K. As a result of s, the nature of the ferric ion relaxation is more clearly defined er the low-temperature region.

14778 APPARENT PERMEABILITY AND INTRINSIC PERMEABILITY AT MICROWAVES. A.J.Berteaud.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 113-17 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The apparent and intrinsic permeability of yttrium iron garnet at microwave frequencies was measured for a number of samples. It is shown that the intrinsic permeability is not really more intrinsic than the apparent permeability and that the position of the intrinsic resonance is not constant for a given material but is a function of the linewidth as is shown by a series of experiments on yttrium iron garnet samples having different surface states and therefore different linewidths. It is therefore concluded that the apparent permeability is the more important quantity. P.E.Seiden

14779 FERRIMAGNETIC LINEWIDTH OF SINGLE CRYSTALS OF BARIUM FERRITE ($BaFe_{12}O_{19}$).
I.Bady, T.Collins, D.J.DeBitetto and F.K.du Pré.
Proc. Inst. Radio Engrs (USA), Vol. 48, No. 12, 2033 (Dec., 1960).

The single crystal linewidth of barium ferrite was measured in two ways: (1) By placing a small polished wafer, ground from a single crystal of barium ferrite, in a rectangular waveguide and determining the variation in transmitted power as a function of applied field. Measurements were made at 55 kMc/s, and the narrowest linewidth obtainable was 50 Oe. The resonance field was 7600 Oe, in good agreement with the anisotropy field value. (2) By placing a small spheroid half a wavelength from the shorted end of a section of waveguide and determining the variation in v.s.w.r. as a function of the applied field. In this case, measurements were made at 57.7 kMc/s. The narrowest linewidth obtained was 53 Oe, and the resonance field 5000 Oe, which is also in good agreement with the anisotropy field. S.A.Ahern

14780 FERRIMAGNETIC RESONANCE OF SINGLE-CRYSTAL BARIUM FERRITE IN THE MILLIMETER WAVE REGION. F.F.Y.Wang, K.Ishii and J.B.Y.Tsui.
J. appl. Phys. (USA), Vol. 32, No. 8, 1621-2 (Aug., 1961).

Ferrimagnetic resonance experiments were performed on a single crystal of barium ferrite, $BaFe_{12}O_{19}$, at frequencies in excess of 50kMc/s. The dependence of resonant frequency on d.c. magnetic field fit the theory of Weiss and Anderson (Abstr. 6296 of 1955) including anisotropy. The anisotropy field was found to be 18.4 kOe, while g equalled 1.87. The linewidths were in the neighbourhood of 10 Oe. P.E.Seiden

14781 VARIATION OF THE RESONANCE PROPERTIES OF YTTRIUM IRON GARNET WITH THE SUBSTITUTION OF Al^{3+}. A.J.Berteaud.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 312-18 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Ferrimagnetic resonance measurements were made of the g-value and line-width of polycrystalline Al substituted YFe garnet as a function of firing conditions and density. The g-value decreases with aluminium content by about 1% from pure YFe garnet to $3.5Fe_2O_3.1.5Al_2O_3.3Y_2O_3$. The line-width is minimized by annealing above 1400°C, where maximum density is obtained. For the maximum density the line-width is seen to be almost independent of composition, varying roughly from about 100 Oe to about 40 Oe with increasing aluminium content. Porosity broadening decreases with increasing aluminium content because of the decrease in saturation magnetization. P.E.Seiden

14782 ORIENTATION OF SINGLE CRYSTAL GARNET BY MAGNETIC RESONANCE. V.Cagan.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 319-24 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A method is described for the crystalline orientation of single crystal magnetic materials with narrow linewidths, by ferrimagnetic resonance. The orientation is found by measuring the resonant magnetic field and using the Kittel equation including anisotropy to determine the easy and hard axes. For a sample of yttrium iron garnet the precision of orientation is about 2°. P.E.Seiden

14783 THE EXCITATION OF FERRIMAGNETIC RESONANCE BY A PULSED MAGNETIC FIELD. H.Brunet.

C.R. Acad. Sci (France), Vol. 252, No. 19, 2860-1 (May 8, 1961).
In French.

Ferrimagnetic resonance on yttrium garnet was used to produce oscillations of frequency of 8100 Mc/s, with maximum power 10^{-5} W and duration 2×10^{-8} secs. M.A.Taylor

14784 ANTIFERROMAGNETIC RESONANCE IN $CoCl_2 6H_2O$. M.Date.

J. Phys. Soc. Japan, Vol. 16, No. 2, 1337-51 (July, 1961).

An antiferromagnetic resonance experiment was performed on a single crystal of $CoCl_2 6H_2O$ in the frequency range of 9.5 to 47 kMc/s at liquid helium temperature. The result can be understood by the theory of antiferromagnetic resonance developed by Nagamiya (Abstr. 1110 of 1952) and Yosida (Abstr. 8931 of 1952; 3423 of 1953) and also by Ubbink et al. [Physica (Netherlands), Vol. 19, 623 (1953)] except for certain systematic deviations from the theory. These deviations can be removed by introducing a large anisotropic exchange interaction of the symmetric tensor form in place of the ordinary small anisotropy energy. Thus, the effective fields acting on sublattice magnetizations, M^+ and M^-, are assumed to be of the form

$$H_E^{\pm} = -AM^{\mp} - \Gamma M^{\pm} - A'M^{\mp} - \Gamma' M^{\pm},$$

where A and Γ are the isotropic molecular field constants and A' and Γ' are newly introduced anisotropic molecular field tensors. It was found that the symmetry axes of A' and Γ' coincide with those of the g-tensor and their components are given by

$$A_x' = 0.25\ A, \quad A_y' = 0.20\ A, \quad A_z' = -0.45\ A,$$

$$\Gamma_x' = 0.19\ A, \quad \Gamma_y' = 0.18\ A, \quad \Gamma_z' = -0.37\ A,$$

where x, y and z correspond to the c-, b- and a'-axes, respectively. Line width measurements were also performed in the para- and anti-ferromagnetic regions and a rapid narrowing was observed at low temperatures.

14785 EXPERIMENT WITH A TRANSIENT EXCITATION OF ELECTRONIC MAGNETIC RESONANCE AT ORDINARY TEMPERATURES. J.G.Théobald and J.Uebersfeld.

C. R. Acad. Sci. (France), Vol. 252, No. 22, 3426-7 (May 29, 1961).
In French.

A transient excitation of paramagnetic resonance was obtained by sweeping a high-frequency electron beam on anthracite carbon. The resonant frequency of oscillations was twice that of the sweep frequency (1 Mc/s), the period of which was comparable to the longitudinal and transverse relaxation times (10^{-7} sec) of the carbon. J.K.Skwirzynski

14786 SPLITTING OF PARAMAGNETIC RESONANCE LINES IN INHOMOGENEOUS FIELDS. V.N.Lazukin.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 408-10 (Feb., 1961).
In Russian.

The splitting is discussed qualitatively and the results of a preliminary experiment on anthracite are mentioned. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 297-8 (Aug., 1961)] K.N.R.Taylor

14787 PARAMAGNETIC RESONANCE OF DEFECTS INTRODUCED NEAR THE SURFACE OF SOLIDS BY MECHANICAL DAMAGE. G.K.Walters and T.L.Estle.

J. appl. Phys. (USA), Vol. 32, No. 10, 1854-9 (Oct., 1961).

Electron spin resonance characteristics of a number of materials subjected to violent mechanical treatment are reported. A line with g = 2.0055 observed in silicon is attributed to defects introduced near the surface by mechanical damage. The resonance properties are not influenced by interaction of the silicon surface with atmospheric gases. Similar lines appear in germanium, silicon carbide, and diamond. The principal line produced by mechanical damage to MgO is attributed to F centres. Similar lines are observed in other II-VI compounds. Results are also reported for a number of other materials: similarity between the defects produced mechanically and by fast neutrons is noted.

14788 SECOND-ORDER EFFECT OF SPIN—ORBIT INTERACTION ON THE PARAMAGNETIC RESONANCE SPECTRA OF IONS WITH A SINGLE 3d ELECTRON. D.K.Ray.

Nuovo Cimento (Italy), Vol. 21, No. 1, 1-6 (July 1, 1961).

In order to explain in a better way the covalent bonding factors for ions with a single 3d electron, the second-order g-factors arising out of the mixing of orbital doublet states with orbital doublet states with orbital triplet states through spin—orbit i action, are revaluated for crystal fields of different symmetris. On the basis of these expressions, the e.p.r. spectra of Ti^{3+} i some salts and of V^{4+} in TiO are discussed.

A PARAMAGNETIC-RESONANCE STUDY OF THE EFFE
A FLUX ON THE STATE OF AN ACTIVATOR IN A PHOSPHO
See Abstr. 14636

14789 PARAMAGNETIC RESONANCE OF Mn^{++} ASSOCI WITH IMPURITIES IN ALKALI CHLORIDES.

Y.Yokozawa and Y.Kazumata.
J. Phys. Soc. Japan, Vol. 16, No. 4, 694-700 (April, 1961).

The paramagnetic resonance absorption of Mn^{2+} ions assoc with the impurities of F or divalent anions was investigated in single crystals of NaCl and LiCl. A resolved fine structure w observed in an "unquenched crystal" and it did not fade into a broad single line in contrast with the spectra of Mn^{2+} ions whi are usually observed in alkali halides. The ground level splitt parameters were determined in the spin Hamiltonian $DS_1^2 +$ $+ E(S_2^2 - S_3^2)$ as follows: $D = (-420 \pm 1) \times 10^{-4}$ cm^{-1}, $|E| = (65 \pm 1) \times 10^{-4}$ cm^{-1} for $Mn^{2+} - F^-$, $D = (-511 \pm 5) \times$ $\times 10^{-4}$ cm^{-1}, $|E| = (25 \pm 5) \times 10^{-4}$ cm^{-1} for $Mn^{2+} - X^{2-}$, a Mn divalent anion pair, in NaCl, and $D = (-672 \pm 5) \times 10^{-4}$ cm^{-1}, $|E| = (12 \pm 3) \times 10^{-4}$ cm^{-1} for $Mn^{2+} - X^{2-}$ in LiCl, the principa axes of the spin Hamiltonian being in near agreement with the cubic axes of the crystal. The large value of D suggests the existence of the strong attractive force between Mn^{2+} and impu ion.

14790 ELECTRON SPIN RESONANCE OF MANGANESE I AMMONIUM CHLORIDE. H.Abe and H.Shirai.

J. Phys. Soc. Japan, Vol. 15, No. 9, 1711 (Sept., 1960).

$MnCl_2$ in NH_4Cl crystals was studied at 20° C and 23110 Mc A many-line spectrum was observed over a wide magnetic fiel range. The results are expressed with a spin Hamiltonian: $\mathcal{H} = g\beta\vec{H}\vec{S} + DS_z^2 + A\vec{I}\vec{S}$ with g = 1.984 (isotropic) D = 1600 ± 25 ar A = 93 ± 4. The results suggest that the Mn ion substitutes for NH_4 ion and that one of the six nearest neighbour NH_4 positions becomes vacant. No explanation is offered for the anomalously large crystalline field parameter D. C.J.

14791 FURTHER NOTES ON THE MAGNETIC CENTERS NEUTRON-IRRADIATED CALCITE. J.C.Kemp.

J. chem. Phys. (USA), Vol. 35, No. 1, 377-8 (July, 1961).

Complex electron spin resonance spectra, observed at temperatures between 77° K and 300° K using a spin-echo metho were qualitatively different from those observed at lower tempe atures (Abstr. 1258 of 1961). Infrared absorption studies supp the speculation that one set of lines, consisting of a triplet belo about 200° K and a singlet above, may be associated with electr trapped about CO_2 molecules. E.F.W.Sey

14792 SPECTRAL DIFFUSION IN ELECTRON RESONANC LINES. W.B.Mims, K.Nassau and J.D.McGee.

Phys. Rev. (USA), Vol. 123, No. 6, 2059-69 (Sept. 15, 1961).

Spectral diffusion in the inhomogeneous paramagnetic reso lines of Ce^{3+} and Er^{3+} in $CaWO_4$ at concentration $\sim 10^{18}$ spins/ was studied by electron spin-echo techniques. Measurements s that the spreading of excitation through the line can be approximately described by a diffusion kernel in the form of a Lorentz function whose width is linear in time. Local field fluctuations due to spin—spin flips and spin—lattice flips appear to be the primary cause of diffusion. In $(Ca,Ce)WO_4$ below 4.2° K the lat time is long, and spin—spin flips predominate, leading to a diffu rate which is independent of temperature. In $(Ca,Er)WO_4$ lattic relaxation is more rapid, and the diffusion parameter, varies a lattice time. Nuclei of W^{183} in the host crystal were observed t give a modulation in the envelope of spin echoes, but the corresponding local fields are smaller than those arising from electr spins at the concentrations studied.

14793 PARAMAGNETIC RELAXATION IN CRYSTALS OF COPPER POTASSIUM CHLORIDE AND CHROMIU POTASSIUM ALUM AT LIQUID HELIUM TEMPERATURES.

J.van den Broek, L.C.van der Marel and C.J.Gorter.
Physica (Netherlands), Vol. 27, No. 7, 661-80 (July, 1961).

Paramagnetic relaxation is studied at liquid helium tempe atures in relatively large crystals of copper potassium chlorid

iromium potassium alum. The susceptibility of copper
sium chloride is found to follow a Curie—Weiss law with a
temperature of about 1° K. This Curie temperature, and
iecific heat C_M of the spin system, are in approximate agree-
with the value of the exchange integral estimated from para-
etic resonance experiments. There is a satisfactory agree-
between calculated and measured paramagnetic saturation
s. At temperatures above the lambda-point of liquid helium,
h salts paramagnetic dispersion and absorption deviate
derably from Casimir and Du Pré's formulae. They are in
actory agreement with a description given by Eisenstein, if
e heat conductivity of the crystals a value is used which is
a factor of ten smaller than the heat conductivity measured
tly by Bijl in single crystals of chromium potassium alum.
v the lambda temperature Casimir and du Pré's formulae are
d, indicating a much better heat contact between crystal and
l helium bath than is present at higher temperatures.

794 A STUDY OF THE ELECTRON PARAMAGNETIC RESONANCE OF Cu^{++} IN COPPER SULPHATE NETICALLY DILUTED WITH MAGNESIUM SULPHATE.

oult and A.M.Duchaux.
. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 199-204 (1960).
ench.
9th Colloque Ampère Paper (see Abstr. 4734 of 1961). The
nance was studied at 90° K and 3 cm wavelength. The angular
ation of the hyperfine structure corresponds with the structure
e crystal, and in certain orientations the effect of the quadrupole
action is seen as a doubling of the hyperfine structure compon-
.

J.M.Baker

4795 PARAMAGNETIC RESONANCE OF SOME COPPER COMPLEX COMPOUNDS. J.A.McMillan and B.Smaller.

iem. Phys. (USA), Vol. 35, No. 2, 763-4 (Aug., 1961).
The ESR spectra of Cu(II) α-picolinate, Cu(II) dipyridyl$_2$ SO_4,
I) pyridine$_4$ SO_4 and Cu(II) pyridine$_4$ S_2O_8 were observed at 77° K
g a double modulation technique at 9 kMc/s. The behaviour of
e compounds is very different from the isomorphous Ag(II)
pounds.

C.J.Ultee

4796 RESONANCE OF THE Gd^{3+} ION IN FLUORITE WITH CHARGE COMPENSATION.

erro and R.Lacroix.
h. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 194-8 (1960).
rench.
9th Colloque Ampère Paper (see Abstr. 4734 of 1961).
amagnetic resonance was studied at 9190 Mc/s in an artificial
stal containing 0.01% Gd^{3+}. A theoretical analysis of the
ctrum is presented, and a comparison with the cubic spectrum
d^{3+} in fluorite enables the effect of the single charge-
pensating F^- ion to be considered. It is concluded that the
ctrum cannot be explained without postulating some admixture
xcited configurations into $4f^7$. Brief mention is also made of
eriments on fluorite in which the charge compensation is
ieved by an O^{2-} substituted for an F^- rather than an interstitial
ion.

J.M.Baker

14797 ELECTRON SPIN RESONANCE OF X-RAY IRRADIATED SINGLE CRYSTALS OF GLUTAMIC ACID HYDRO-LORIDE. W.C.Lin, C.A.McDowell and J.R.Rowlands.

hem. Phys. (USA), Vol. 35, No. 2, 757-8 (Aug., 1961).
The e.s.r. spectra obtained from glutamic acid HCl irradiated
h 50 keV X-rays at room temperature shows good agreement
h that calculated for an α-succinyl type radical.

C.J.Ultee

14798 INVESTIGATIONS ON U.V. IRRADIATED LITHIUM HYDRIDE CRYSTALS BY ELECTRON RESONANCE.

.E.Ingram and M.J.A.Smith.
ch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 213-18 (1960).
9th Colloque Ampère Paper (see Abstr. 4734 of 1961).
adiation of LiH for about 15 min gives rise to a strong narrow
.r. absorption line which is attributed to the free electrons in
loidal lithium particles. The temperature dependence of the
.r. intensity supports this interpretation. Irradiation of lithium
minium hydride produced only a weak signal after 15 hr; the
ge line width and temperature dependence of the intensity
gest that it is due to crystal defects and not to the formation
colliodal lithium particles. It thus appears that in LiH the u.v.
anta have sufficient energy to eject the Li atoms from their sites
that they can then coalesce to form colloidal particles, whereas
in lithium aluminium hydride the movement of the lithium atoms is much more restriced and they do not form colloidal particles.

J.M.Baker

14799 HYPERFINE STRUCTURE OF THE NAPHTHALENE TRIPLET STATE. A.Schmillen and G.v.Foerster.

Z.Naturforsch. (Germany), Vol. 16a, No. 3, 320 (March, 1961).
In German.

Reports h.f.s. splitting in the triplet state paramagnetic resonance spectrum of naphthalene solid solutions in durene single crystals. Five h.f.s. components were observed and attributed to dipole—dipole coupled spins of the four alpha-protons. Further splitting due to the beta-protons was not observed. It is estimated that one naphthalene molecule in 10^3 was in the triplet state for the 5 mole % naphthalene solution used.

P.M.Parker

ELECTRON SPIN RESONANCE OF ELECTRON EXCESS CENTRES IN KCl. See Abstr. 14330

14800 E.S.R. SPECTRA OF A GAMMA-IRRADIATED SINGLE CRYSTAL OF DL-SERINE.

D.V.G.L.Narasimha Rao and W.Gordy.
J. chem. Phys. (USA), Vol. 35, No. 2, 764-5 (Aug., 1961).

Gamma-irradiation (10^7 r) at room temperature of a DL-serine single crystal grown in D_2O leads to a complex e.s.r. spectrum. After six months storage an isotropic doublet of 40 G separation remained. The spectrum is assigned to the $(DO)_2\dot{C}CH(ND_2)CH_2OD$ radical.

C.J.Ultee

14801 PARAMAGNETIC RESONANCE OF Mn^{++}-F^- PAIR IN SODIUM CHLORIDE. Y.Yokozawa.

J. Phys. Soc. Japan, Vol. 15, No. 6, 1131-2 (June, 1960).

The spin resonance spectrum of a Mn^{2+} F^- pair in NaCl is described. The constants in the spin Hamiltonian are determined. From the value of A_s it is estimated that the σ-bond of the Mn^{2+} F^- pair has 0.45% 2s character.

C.J.Ultee

14802 ELECTRON SPIN RESONANCE OF Mn^{++} IN $SrCl_2$, $CdCl_2$ and $CdBr_2$. H.Koga, K.Horai and O.Matumura.

J. Phys. Soc. Japan, Vol. 15, No. 7, 1340 (July, 1960).

Measurements were made at room temperature and wavelengths of 3 and 0.8 cm on crystals grown from the melt in a quartz tube under a vacuum of about 10^{-3} mm Hg. In $SrCl_2$ the spectrum shows predominantly cubic symmetry at low Mn concentrations but has large axial terms at high Mn concentrations. The spectra in the other two crystals have axial symmetry at all concentrations. Some results are also given for $MgBr_2$ and $BaCl_2$ containing manganese.

J.M.Baker

14803 NOTE ON MEASUREMENT OF RATES OF ELECTRON TRANSFER PROCESSES BY BROADENING OF E.S.R. LINES. P.J.Zandstra and S.I.Weissman.

J. chem. Phys. (USA), Vol. 35, No. 2, 757 (Aug., 1961).

It is shown that in the case of electron transfer between naphthalene negative ion and naphthalene [Ward and Weissman, J. Amer. Chem. Soc., Vol. 79, 2086 (1957)] the electron exchange rate does not depend on nuclear spin states. Also the magnetic pulses during transit do not contribute to line breadth.

C.J.Ultee

14804 E.P.R. STUDIES OF SPIN CORRELATION IN SOME ION RADICAL SALTS. D.B.Chesnut and W.D.Phillips.

J. chem. Phys. (USA), Vol. 35, No. 3, 1002-12 (Sept., 1961).

Electron spin resonance studies were carried out on a number of ion-radical salts based on the strong π-acceptor tetracyanoquinodimethane (TCNQ). These studies have established that spin correlation exists between the magnetic electrons in these salts, giving rise to a ground singlet state and a thermally accessible triplet state. Typical singlet-triplet separations (J) derived from observed temperature dependences of e.p.r. signal intensities are 0.034 eV for the $[(C_2H_5)_3NH]^+(TCNQ)_2^-$ salt, 0.062 eV for the $(\varphi_3PCH_3)^+(TCNQ)_2^-$ and $(\varphi_3AsCH_3)^+(TCNQ)_2^-$ salts, and 0.41 eV for the (morpholinium)$^+$ $(TCNQ)^-$ salt. The triplet states of the $(\varphi_3PCH_3)^+(TCNQ)_2^-$ and $(\varphi_3AsCH)^+(TCNQ)_2^-$ salts are further manifested by an anisotropic splitting of the resonance into a doublet (zero-field splitting) and the appearance of half-field $\Delta m = \pm 2$ transitions. Detailed analysis reveals that both salts may be represented by the spin Hamiltonian

$$\mathcal{H} = \beta H \cdot g \cdot S + DS_z^2 + E(S_x^2 - S_y^2),$$

with $|D/hc| = 0.0062\ cm^{-1}$, $|E/hc| = 0.00098\ cm^{-1}$, and g_x, g_y, and g_z equal to 2.004_0, 2.003_1, and 2.002_7, respectively. Temperature-dependent exchange interactions observed for the $(\varphi_3PCH_3)^+(TCNQ)_2^-$

and $(\varphi_3AsCH_3)^+$ $(TCNQ)_2^-$ salts cause the doublet zero-field components to broaden, move together, and collapse into a single, progressively sharper line as the temperature is increased. The exchange frequency follows an exponential temperature dependence and is governed by the concentration of triplet entities in the solid ($J = 0.062$ eV). The importance of paramagnetic impurities in studies of the magnetic properties of organic solids is emphasized. Examples are given which illustrate how a percent or so of doublet-state impurity species can dominate resonances near $g = 2.002$ in molecular solids obeying singlet-triplet statistics.

14805 HYPERFINE STRUCTURE AND g-TENSOR ANISOTROPY OF THE PARAMAGNETIC RESONANCES OF MANGANESE IN TiO$_2$.

H.G.Andresen.

J. chem. Phys. (USA), Vol. 35, No. 3, 1090-6 (Sept., 1961).

Several characteristic resonances of the paramagnetic spectrum of a manganese-doped TiO_2 single crystal in its rutile structure were measured with high precision in order to improve the accuracy of the spin Hamiltonian parameters. The measurements were performed at room temperature and at X-band frequencies. Especially, the anisotropy of the g tensor and that of the A tensor were evaluated using the resonance data measured at orientations of the magnetic field parallel to the three magnetic axes of the rutile crystal. The hyperfine structure patterns of the manganese resonances are discussed qualitatively for various crystal orientations; two properly selected $|\Delta m_I| = 1$ transitions were used to estimate the upper limit of the quadrupole-term parameters of the spin Hamiltonian. The paramagnetic resonances of manganese in rutile were also investigated at liquid nitrogen temperature and at X-band frequencies. Aside from a spectrum that is very similar to the spectrum already observed at room temperature and assigned to tetravalent manganese atoms, having a spin value of $S = \frac{3}{2}$, additional manganese resonances of strong intensity were observed. Though it is very likely that these resonances can be attributed to manganese atoms of a different valence state, the paramagnetic data at X-band frequencies are insufficient to determine the origin of these resonances unambiguously.

14806 ZERO-FIELD SPLITTING OF THE Cr^{3+} GROUND STATE IN YGa AND YAl GARNET.

J.W.Carson and R.L.White.

J. appl. Phys. (USA), Vol. 32, No. 9, 1787 (Sept., 1961).

The zero-field splittings arising from trigonal distortion were deduced from paramagnetic resonance spectra at 35 kMc/s. The observed spectra are in agreement with theoretical predictions, and values for the zero-field splitting and $g_{\parallel}$ from measurements at 300° and 77° K are given for both garnets. The results are consistent with the assumption that the oxygen octahedron is more regular in the YAl garnet. C.D.Lustig

14807 ON THE THEORY OF CROSS RELAXATION IN MASER MATERIALS.

M.Hirono.

J. Phys. Soc. Japan, Vol. 16, No. 4, 766-76 (April, 1961).

A theoretical study of cross relaxation in maser materials was carried out based on the moment method. The energy level splittings due to the crystalline electric field and the applied magnetic field are utilized for the computation of the moments of the cross relaxation. If the lattice points are populated at random by paramagnetic ions in highly diluted salts, the second moment is much greater than the overlap integral of the individual ordinary resonance line shapes and to some extent influenced by the orientation of the applied magnetic field. The shape function of the cross relaxation is roughly Gaussian but takes slightly less values in the wings. The cross relaxation in a ruby maser successfully operated at liquid nitrogen temperatures is briefly discussed.

14808 SPIN—LATTICE RELAXATION IN CERIUM MAGNESIUM NITRATE AT HELIUM TEMPERATURES; A NEW PROCESS.

C.B.P.Finn, R.Orbach and W.P.Wolf.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 108-10 (1960).

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Measurements were made between 1.9° and 3°K and for a large part of this region the relaxation time varied as $\exp(\Delta/kT)$ where Δ is the energy of an excited state of the cerium ion ($\Delta/k \cong 34°K$). It is suggested that the mechanism of relaxation is through two direct phonon processes; one to, and one back from the excited level. Phonons are available for such processes if $\Delta < k\Theta_D$. The theory of this mechanism has been developed not only to give the correct temperature dependence but also remarkably good qnti tative agreement with the numerical value. Outside the narrv temperature range studied the temperature dependence is dire indicating that other relaxation mechanisms become more inor

J.M.Ba

14809 SPIN—LATTICE RELAXATION IN SOME RARE-A ETHYLSULPHATES.

A.H.Cooke, C.B.P.Finn and R.Orbach.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 111-12 (1960

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Te relaxation time between 3.0° and 1.6°K for both dysprosium ad ytterbium salts are proportional to exp (Δ/kT) where Δ is th energy of an excited state of the magnetic ions, between whic a the ground state direct phonon transitions can occur. This tye transition thus appears to be the dominant relaxation process The temperature dependence of the relaxation time in the necy and erbium salts is different from that of the other two salts

J.M.Ba

14810 MEASUREMENT OF THE SPIN—LATTICE RELAA TION TIME IN COMPOUNDS WITH STRONG COVALENT BONDING.

P.P.Pashinin and A.M.Prokhorov.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 49-51 (Jan., 19

In Russian.

T_1 for Fe^{3+} and Cr^{3+} ions in $K_3(Fe,Cr)(CN)_6$ was measur the methods of pulsed and continuous saturation. For Fe^{3+} cc trations of 0.1 and 0.21%, T_1 was found to be independent of c tration in the temperature range from 2.1 to 40°K and equal t $0.64\,\theta^{-5}$ sec (where θ is the temperature in °K). The expe ment shows in a qualitative way that there is a strong cross r tion between the lines from the two non-equivalent ions. The urements of T_1 for Cr^{3+} also indicate the existence of cross r tion. [English translation in: Soviet Physics—JETP (USA), V No. 1, 33-4 (July, 1961)].

14811 SPIN—LATTICE RELAXATION TIME MEASUREM IN DILUTE POTASSIUM FERRICYANIDE.

D.H.Pa

Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 180-4 (Aug., 1961).

Measurements of the spin—lattice relaxation time of T_1 o $K_3Fe(CN)_6$ diluted with $K_3Co(CN)_6$ were made in the temperatu range 4.2° to 1.6°K in the X-band (9375 Mc/s). The results ar compared with existing theories, and it is suggested that the r are not inconsistent with the theory proposed by Van Vleck (19

14812 SPIN—LATTICE RELAXATION OF PAIRS OF CHROMIUM IONS IN RUBY.

J.C.Gill.

Nature (GB), Vol. 190, 619-20 (May 13, 1961).

Measurements were made between 1.4 and 100°K in a crys containing 0.12% chromium of the recovery after saturation of some of the more prominent lines in the X-band e.s.r. "pair" spectrum. The recovery was usually adequately described by single time const varies as 1/T. At higher temperatures it varies more rapidly at the very lowest temperatures for some of the lines it becom temperature independent. The relaxation of pairs is 10-300 ti faster than that of single ions in the same crystal. This may possibly provide an explanation of the concentration-dependent relaxation times commonly observed in ruby. J.M.

14813 DIFFUSION PHENOMENA IN DOUBLE MAGNETIC RESONANCE IN THE CASE WHERE THE ELECTR RESONANCE LINE IS INHOMOGENEOUS.

J.L.Motchane and J.Uebersfeld.

Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 682-5 (1960

French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A theoretical treatment shows that the inhomogeneous character electronic line considerably diminishes the amplification coeff ent of nuclear polarization.

14814 NUCLEAR DYNAMIC POLARIZATION IN IRRADIA POLYTETRAFLUORETHYLENE.

G.E.G.Hardema

Philips Res. Rep. (Netherlands), Vol. 15, No. 6, 587-97 (Dec.,

An account is given on the electron nuclear double resonar in samples of polytetrafluorethylene containing paramagnetic centres obtained by irradiation with fast electrons. The polari of the F^{19} nuclei is enhanced when combined nuclear and electr spin transitions are induced by a radiation field. This effect ca observed with the aid of nuclear magnetic resonance. The amo of this "dynamic polarization" depends on the concentration of paramagnetic centres, the intensity of the radiation field and th ıary external magnetic field. While the number of para- ·tic centres is much smaller than that of the F^{19} nuclei, the ır dynamic polarization is transported from the centres and ɔuted over the total nuclear-spin system by means of nuclear- iffusion. It proves that the nature of the electron paramag- resonance-line shape is of great importance for this process.

815 DOUBLE PARAMAGNETIC RESONANCE OF CRYSTAL-INCORPORATED ATOMS AND F-CENTRES IN MIXED TALS.

M.F.Deihen and O.B.Roitsȳn.

ɹin. fiz. Zh. (USSR), Vol. 3, No. 4, 439-48 (1958). In Ukrainian.

dependence is found of the frequencies of spin-nucleus trans- in a crystal containing local electron centres on the orienta- f the crystal in an external static magnetic field. The ctive angular dependences of spin—nucleus transitions in ıtres of pure and mixed crystals, as well as in incorporated s in NaCl- and CdS-type crystals, are discussed. The results ıed permit one to determine (with great precision) the value square of the localized-electron wave-function at various e points, and to judge the environment of the defect (short- order).

1816 THE THEORY OF DOUBLE ELECTRON AND NUCLEAR RESONANCE IN SYSTEMS WITH HYPERFINE INTER ION.

T.G.Izyumova and G.V.Skrotskii.

ksper. teor. Fiz. (USSR), Vol. 40, No. 1, 133-42 (Jan., 1961). ıssian.

The complex susceptibility of electron spins interacting with a ear system is calculated on the basis of the statistical perturba- theory. The dependence of the conditions for the saturation of lectron system on the resonance conditions of the nuclear sys- is obtained. [English translation in: Soviet Physics—JETP), Vol. 13, No. 1, 93-9 (July, 1961)].

4817 THE ELECTRON-COUPLED NUCLEAR SPIN INTER-ACTIONS IN IONIC CRYSTALS BY THE OVERLAP DEL.

T.Shimizu.

hys. Soc. Japan, Vol. 16, No. 6, 1264-5 (June, 1961).

An expression for the interaction energy is obtained from a ond order perturbation calculation and compared with experi- tal results for CsBr. H.Mykura

4818 THE OVERHAUSER EFFECT AND THE ELECTRON PARAMAGNETIC RESONANCE "SECONDARY SIGNAL".

.Kessenikh.

eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 32-3 (Jan., 1961). ussian.

The relative increase in the polarization of the protons in solid ?H as the electron paramagnetic resonance is saturated was ısured (in fields of ~ 3300 Oe) by observing the increase in the lear magnetic resonance signal. It is shown that at large satu- ng power an electron paramagnetic resonance "secondary signal" bserved simultaneously with the nuclear magnetic resonance nal, corresponding to the emission or absorption of an additional ntum by the electron spin system. [English translation in: iet Physics—JETP (USA), Vol. 13, No. 1, 21-2 (July, 1961)].

14819 INVESTIGATION OF PROTON POLARIZATION THROUGH THE OVERHAUSER EFFECT AND OF RAMAGNETIC RELAXATION IN $NO(SO_3)_2^{--}$ SOLUTIONS.

Müller-Warmuth.

Naturforsch. (Germany), Vol. 15a, No. 11, 927-39 (Nov., 1960). German.

A detailed report of the behaviour of the proton spin resonance nal from water acting as solvent for the peroxylamine disulphon- negative ion. The proton signal enhancement due to the Over- ıser effect is studied for irradiation of the various electron spin sonance lines in the magnetic field range 5 to 21 G which covers changeover region from Zeeman to Paschen—Back behaviour. some circumstances a negative enhancement is observed and ıser action is detected. The observed enhancements are broadly agreement with theory. The apparatus used is described in detail. J.G.Powles

14820 A NOTE ON THE MAGNETIC RESONANCE IN METALS.

K.Sugihara.

Phys. Soc. Japan, Vol. 15, No. 9, 1712-13 (Sept., 1960).

The effect of the anomalous skin effect on the line shape of a clear magnetic resonance line is considered. C.J.Ultee

14821 MACROSCOPIC EQUATIONS FOR THE MAGNETIC MOMENT IN SOME MAGNETIC RESONANCE PROBLEMS.

N.N.Korst.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 249-55 (Jan., 1961). In Russian.

A method is proposed for passing from Bloch's kinetic equations for the density matrix to the equations for the macroscopic magnetic moment of a nuclear system consisting of interacting spins. The method is applied to the problem of three equivalent particles of spin $\frac{1}{2}$ coupled to each other by dipole—dipole interaction. The solution of the equations obtained is given. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 171-5 (July, 1961)].

14822 ENERGY TRANSFER WITHIN A SPIN SYSTEM.

D.F.Holcomb, B.Pedersen and T.R.Sliker.

Phys. Rev. (USA), Vol. 123, No. 6, 1951-7 (Sept. 15, 1961).

The nature of the transfer, within a single nuclear spin system, of energy absorbed from an external source of radio-frequency magnetic field was investigated by a double-irradiation technique. Energy from a high-power oscillator running at fixed frequency is absorbed by the nuclear spin system. The frequency of a second, low-level oscillator is then swept through the nuclear resonance, sampling the line shape existing in the presence of the strong r.f. field from the fixed-frequency oscillator. Particular spin systems investigated were the proton system in single crystalline $CaSO_4.2H_2O$, and the Al^{27} system in aluminium metal. In aluminium, the technique gives direct experimental verification of a completely homogeneous saturation behaviour, a behaviour expected from elementary considerations. It also gives further verification of the Redfield saturation theory. In $CaSO_4.2H_2O$, an enhancement effect is observed which allows one to determine the importance of double-flip spin—lattice relaxation processes. The technique could be usefully applied to many spin systems to determine the degree of inhomogeneity in the resonance line broadening.

14823 LINEAR EFFECT OF APPLIED FIELD ON MAGNETIC HYPERFINE INTERACTION.

N.Bloembergen.

Phys. Rev. Letters (USA), Vol. 7, No. 3, 90-2 (Aug. 1, 1961).

A general theoretical discussion is given and specific calculations are made for MnF_2 which show that an effect should be observable for a field of 10^4 volts/cm. Experiments are being carried out. D.J.Oliver

14824 ISOTOPE EFFECT IN THE NUCLEAR MAGNETIC RESONANCE IN RUBIDIUM.

W.E.Blumberg, J.Eisinger and M.P.Klein.

Phys. Rev. (USA), Vol. 124, No. 1, 206-7 (Oct. 1, 1961).

By performing precise measurements of the nuclear magnetic resonance frequencies at constant field of the stable Rb isotopes in a metallic sample and in RbCl solution, the authors determined $\Delta = k^{85}/k^{87} - 1 = (0.38 \pm 0.03)\%$, where $k^{85,87}$ is the Knight shift of $Rb^{85,87}$. Δ is the hyperfine structure anomaly which will be equal to $\Delta(s_{1/2})$, determined from $Rb(5s\,S_{1/2})$ atomic beam experiments only if the hyperfine interaction responsible for the Knight shift arises from $s_{1/2}$ conduction electrons. The experimental results show that to high precision this is the case.

14825 ANISOTROPY OF NUCLEAR MAGNETIC RESONANCE IN VANADIUM PENTOXIDE.

J.L.Ragle.

J. chem. Phys. (USA), Vol. 35, No. 2, 753-4 (Aug., 1961).

The shift and splitting of the central component of the V^{51} resonance in V_2O_5 leads to $\sigma_\perp = +(2.0 \pm 0.2) \times 10^{-4}$ and $\sigma_\parallel = -(3.5 \pm 0.4) \times 10^{-4}$ relative to a $NaVO_3$ solution. These values represent a superposition of paramagnetic and diamagnetic effects in both V_2O_5 and the reference. C.J.Ultee

14826 LINE SHAPE OF PROTON MAGNETIC RESONANCE IN PARAMAGNETIC SOLIDS.

D.J.Kroon.

Philips Res. Rep. (Netherlands), Vol. 15, No. 6, 501-83 (Dec., 1960).

The paper deals with an investigation carried out to find the influence of paramagnetic ions on the second moment of mean-square width of the proton magnetic resonance line in solids. The general shape of the resonance line is studied as well. Under the assumption that the paramagnetic ions may be considered as point dipoles it is possible to indicate three sources of line broadening. These are (a) a composition broadening, due to non-identical environments of nuclei in different unit cells of the specimen, (b) a broadening caused by non-cubic environments of the nuclei, and (c) a broadening due to the non-spherical shape of the crystallities constituting a porous specimen. The contribution to the second moment arising from these three causes is evaluated. To verify the theory, experiments were carried out on powdered samples having the chemical composition $NH_4Fe_xAl_{1-x}(SO_4)_2$. The proton magnetic resonance lines were measured at 77°K. These experiments prove that the behaviour of the second moment as a function of the Fe concentration is described in good approximation by the theory. An additional broadening, occurring mainly when the Fe concentration is low, may be ascribed to a short—lattice relaxation time. It is possible to indicate the positions of the protons in the crystal lattice. It is found that even at very low temperatures (20°K) the protons are in rapid motion. This has been the basis for the calculation of the contribution of the crystal anisotropy to the second moment. The contribution thus calculated is of the same order of magnitude as the measured value of the second moment, and the discrepancy is ascribed to the spatial extension of the magnetic moment of the paramagnetic ion. The broadening of the line as a result of the non-spherical shape of the crystallites is determined by measurements on diluted samples. Finally the shape of the resonance line is calculated and the result is compared with the observed line shape. The fact that they were in good agreement is a strong argument in favour of the indicated proton positions. In the experimental part a description is given of a simple spectrometer for nuclear magnetic resonance measurements on solids. The design considerations for this spectrometer led to a rapid and accurate method for designing permanent magnets. The paper also contains a calculation of the line distortion resulting from the measuring method, and means of correction are discussed.

14827 NUCLEAR MAGNETIC RESONANCE OF PROTONS ABSORBED IN Pd AND SOME DILUTE Pd-Fe ALLOYS.

J.P.Burger, N.J.Poulis and W.P.A.Hass.
Physica (Netherlands), Vol. 27, No.6, 514-22 (June, 1961).
In French.

Measurements were made as a function of temperature and of the concentration of hydrogen absorbed. The observation of a minimum for T_1 confirms the existence of proton movements. The curve of T_2 versus temperature for unsaturated Pd possesses a maximum which suggests an inhomogeneous distribution of protons in the palladium. D.J.Oliver

14828 SOME REMARKS ON THE PROFILE OF RESONANCE LINES OF PROTONS IN PARAMAGNETIC SOLIDS.

D.J.Kroon.
Arch Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 392-5 (1960).
In French.

9th Colloque Ampere Paper (see Abstr. 4734 of 1961). A formula is presented for calculating the second moment for a polycrystalline sample containing paramagnetic ions. Application to $(NH_4)\,Fe_x\,Al_{1-x}(SO_4)_2$ gives good agreement with experimental data. C.J.Ultee

14829 PROTON MAGNETIC RESONANCE IN DPPH AT LOW TEMPERATURE.

J.Hervé, R.Reimann and R.D.Spence.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 396-401 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). At low temperatures, the spectrum shows considerable structure and at 2°K five lines can be distinguished. The coupling constants deduced from the 2°K spectrum are somewhat lower than those calculated by Gutowsky et al. (Abstr. 8361 of 1959). The dielectric constant of DPPH increases rapidly below 50°K indicating an increase in contribution of ionic structures. This change is probably also responsible for anomalies observed in the e.s.r. spectrum of single crystals of DPPH at low temperatures. C.J.Ultee

14830 MEASUREMENT OF TEMPERATURE DEPENDENCE OF T_1 OF PROTON IN SOME HIGH POLYMERS BY PULSED N.M.R. TECHNIQUE.

T.Kawai, M.Sasaki, A.Hirai, T.Hashi and A.Odajima.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1700 (Sept., 1960).

For polyvinyl acetate and polymethyl acrylate the $\ln T_1$ versus T^{-1} curves are V-shaped, T_1 being determined by segmental motion. For polymethyl methacrylate the curve has another minimum at a lower temperature. The B.P.P. analysis was used to give rough values of the correlation term and the activation energy. D.J.Oliver

14831 ZEROSPLITTING CONE ON THE ZEEMAN EFFECT OF NUCLEAR QUADRUPOLE RESONANCE, SPIN 9/2.

N.Inoue.
J. Sci. Hiroshima Univ. A (Japan), Vol. 29, No. 3, 619-35 (Dec., 1960).

Zerosplitting loci of the nuclear quadrupole resonance spectrum
of Bi^{209} in bismuth trichloride crystals were studied. The pr
axes of the field gradient tensor were found to be determined
the form of the zerosplitting cone. The interpretation used C
Zeeman splitting parameters. Explicit numerical formulas o
relative intensities for the zerosplitting loci, which may be a
to any half integral spin and to arbitrary value of asymmetry
meter were given. Although no careful measurement of the r
intensities was attempted, the order-of-magnitude agreement
numerical calculations was experimentally confirmed.

14832 IMPURITY SHIFT OF PURE QUADRUPOLE RESO FREQUENCY.

Y.Imaeda.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1699 (Sept., 1960).

Frequency shift of pure quadrupole resonance due to impu
content of samples has previously rarely been noticed, except
some cases with exceptionally large shifts. Careful measure
has revealed impurity shifts in almost all cases. Results are
tabulated for shifts in bromates and chlorates. To obtain thes
results stable and sensitive regenerative spectrometers opera
at low r.f. level were essential in order to get faithful absorpt
curves without any heating of the samples which might have re
in a "temperature shift". J.M

14833 NUCLEAR QUADRUPOLE RESONANCES, PHASE CHANGES AND FERROELECTRICITY OF ALKAL IODATES.

F.Herlach.
Helv. phys. Acta (Switzerland), Vol. 34, No. 4, 305-30 (1961).
In German.

Pure nuclear quadrupole resonances of I^{127} were detected
all the alkali iodates, showing that none of these can have a
perovskite-like structure as suggested in the literature. The
encies of the ±1/2 → ± 3/2-transitions were measured in the
ature range from - 196°C to + 300°C. At 20°C, the resonance
frequencies and the signal-to-noise ratios are respectively:
151,2 Mc/s, 2000; $NaIO_3$ 149,3 Mc/s, 140; KIO_3 145.6 Mc/s, 200
145.1 Mc/s, 300; 144.6 Mc/s, 10; 144.1 Mc/s, 15; $RbIO_3$ 145.5
$CsIO_3$ 144.0 Mc/s, 850; NH_4IO_3 147.6 Mc/s, 450. Phase transi
were observed in the Li-, Na-, K-, Cs- and NH_4-salts. KIO_3
quite differently to the other alkali iodates, it undergoes phas
transitions at - 190°C, - 10°C (on heating)/ - 18°C (on coolin
70°C and 212°C. Single crystals of KIO_3 were grown and prov
be ferroelectric below 212°C with changes in the ferroelectri
behaviour at each of the lower transition points. The spontan
polarization in the particular direction studied is about 0.3 μ
and the coercive field about 4 kV/cm. The low-field dielectri
stant is about 10 above 20°C, rising to 170 at - 18°C. The di
of ferroelectricity in KIO_3 is much emphasized by the quadru
resonance apparatus, consisting of a self-quenched superrege
tive receiver with a reliable lock-in system, and a thermosta
covering the whole temperature range from - 170°C to + 500°
are described and discussed. For some additional X-ray mea
ments, a high-temperature powder camera Unicam type S 70
calibrated and slightly modified to obtain a homogeneous tem
ture distribution within the furnace.

14834 QUADRUPOLE INTERACTION IN COLD WORKE COPPER.

P.Averbuch.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 406-9 (196
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). S
distortion of the cubic lattice results in a decrease in the n.m
signal amplitude (peak-to-peak on the derivative curve), while
integrated intensity remains nearly constant. In this region,
second moment is proportional to square of the elastic defor
tensor. As the distortion increases the second moment reach
constant value, while both the integrated intensity and the sig
amplitude drop about 60%. Further increase in the distortion
leads to a further gradual decrease in these parameters.
C.

14835 NUCLEAR QUADRUPOLE EFFECTS IN SPINELS ($MgAl_2O_4$).

E.Brun, S.Hafner and P.Hartmann.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 410-11 (19

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). T
Al^{27} nuclear magnetic resonance spectrum in natural spinel
crystals shows quadrupole splittings due to ions in octahedra
and an unsplit line due to ions in tetrahedral sites. After hea
above 900°C the spectrum is less intense and becomes simila
that observed in synthetic crystals. The change is attributed
order—disorder transition in the cation distribution.
E.F.W.S

836 SHIFT OF NUCLEAR QUADRUPOLE RESONANCE FREQUENCY BY ELECTRIC FIELD.
hida and K.Saiki.
Rev. Letters (USA), Vol. 7, No. 1, 9-10 (July 1, 1961).
he Br^{81} quadrupole resonance in a single crystal of $NaBrO_3$
ound to be shifted and distorted by the application of electric
. of about 10 kV cm^{-1}. This was consistent with a frequency
proportional to the applied field, for each of the non-equivalent
n the unit cell. Such shifts, caused by changes in the electric
gradients at the nuclei, are only expected where, as here, there
inversion symmetry about the nuclear sites. The piezoelectric
ibution to the shift was estimated to be less than 10% of the
.
E.F.W.Seymour

337 LINEAR EFFECT OF APPLIED ELECTRIC FIELD ON NUCLEAR QUADRUPOLE RESONANCE.
nstrong, N.Bloembergen and D.Gill.
Rev. Letters (USA), Vol. 7, No. 1, 11-14 (July 1, 1961).
he second moments of the Cl^{35} resonances in polycrystalline
$)_3$ and $KClO_3$ were found to increase linearly with the strength
applied static electric field, up to the maximum field used
V cm^{-1}). The interpretation is as in the preceding abstract.
stions are made for related experiments, including the induc-
f nuclear spin transitions by a radiofrequency electric field.
E.F.W.Seymour

838 THE TEMPERATURE DEPENDENCE OF THE QUADRUPOLE COUPLING CONSTANT OF ^{23}Na IN
UM NITRATE.
Iennel, E.R.Andrew, S.Clough and R.G.Eades.
. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 412-15 (1960).
th Colloque Ampère Paper (see Abstr. 4734 of 1961). The
ase of the coupling constant by an order of magnitude between
C and 300°C is explained by assuming that the sodium ions
ne free to move predominantly in the plane perpendicular to the
nal crystal axis, because the electric field gradient due to near
bours is shown to decrease markedly away from the axis.
E.F.W.Seymour

839 NUCLEAR QUADRUPOLE RESONANCE IN $TiCl_4$, $ThCl_4$, $NbCl_5$, AND $TaCl_5$. A.H.Reddoch.
em. Phys. (USA), Vol. 35, No. 3, 1085-9 (Sept., 1961).
The chlorine resonance in titanium tetrachloride was re-
ined, confirming the existence of four resonances. A Cl^{35}
nance at about 6 Mc/s was discovered in thorium tetrachloride.
frequency suggests highly ionic bonding, which contradicts
er conclusions from X-ray studies. Some double-bond charac-
nay be present in the Th—Cl bond. Niobium and chlorine reso-
es were discovered in niobium pentachloride. The niobium
nances are described by a single set of parameters, the
ling constant eqQ being approximately 78 Mc/s, and the
metry parameter, $\eta = 0.32$. Because of the large asymmetry
meter, it was possible to observe two $\Delta M = 2$ and one $\Delta M = 3$
sitions. Only a single Cl^{35} resonance was found at about 13 Mc/s,
ugh two more chlorine resonances would be expected on the
s of crystal structure. The frequency of the chlorine resonance
ests appreciable covalency in the niobium-chlorine bond in
ium pentachloride. A single resonance was found in tantalum
achloride at about 13 Mc/s. It is believed to be a Cl^{35} resonance.
irly simple method is outlined for determining the asymmetry
meter of the electric-field gradient from the observed transition
uencies without directly solving the secular equations.

MECHANICAL PROPERTIES OF SOLIDS

1840 AN INTRODUCTION TO APPLIED ANISOTROPIC ELASTICITY. R.F.S.Hearmon.
rd: University Press (1961) viii + 136 pp.
The physical aspects of the subject are emphasized; there
umerous references together with author and subject indexes.
chapter headings are:

Fundamentals;
Elastic constants and symmetry;
Elastic constants of single crystals, sheet materials
  and polycrystalline aggregates;
Some simple stress systems;
Stress and strain distribution;
Wave propagation;
Anisotropic plates.

14841 TWO-DIMENSIONAL ELASTIC INCLUSION PROBLEMS. M.A.Jaswon and R.D.Bhargava.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 3, 669-80 (July, 1961).

This paper deals with a class of problems in classical elasticity theory known as "inclusion" problems: the inclusion may be a cavity or inhomogeneity within an elastic medium, perturbing an otherwise uniform stress field. An account is given of Eshelby's point-force method for solving elastic inclusion problems, and of his equations relating an inhomogeneity to its equivalent inclusion. The introduction of complex variable formalism enables explicit solutions to be found in various two-dimensional cases. Strain energies are calculated. The equilibrium shape of an elliptic inclusion exhibits an interesting feature not previously expected. A fresh analysis of stress magnification effects is developed.

14842 DETERMINATION OF THE ELASTIC CONSTANTS OF TETRAGONAL (4, $\bar{4}$, 4/m) CRYSTALS FROM THE STUDY OF DIFFUSE X-RAY REFLECTIONS.

R.C.Srivastava and S.C.Chakraborty.
Indian J. Phys., Vol. 34, No. 6, 253-9 (June, 1960).

Theoretical relationships connecting diffusely scattered X-ray intensities from a crystal with its elastic constants are derived for tetragonal crystals of classes 4, $\bar{4}$ and 4/m. Methods of evaluation of all the seven elastic constants for these types of crystals from a quantitative measurement of diffuse X-ray scattering only are described.

14843 DEVELOPMENT OF HIGH-TEMPERATURE STRAIN GAGES. J.W.Pitts and D.G.Moore.

Nat. Bur. Stand. (USA), Monogr. No. 26, 1-20 (1961).

A summary is presented of a research programme aimed at the improvement of high-temperature strain gauges of the electrical resistance type. Potential ceramic and metal components were evaluated and a gauge was devised that was based on these evaluations. This gauge (NBS 5B) was flexible and easy to install; however, it lacked resistance stability at higher temperatures. In an attempt to minimize this deficiency, ceramic cements were developed that showed greater electrical resistivity than had been previously observed in the range 800° to 1800°F; also, a technique was devised for increasing the resistance to ground by applying a fired-on ceramic coating to the grid of a specially developed unbacked gauge. A study was made of the cause of the erratic response of cemented gauges that had not been preheated prior to use. There were strong indications that the erratic response was caused mostly by the rapid decrease in resistance that accompanied structural changes in the cement.

14844 FORMULATION OF A THEORY OF ELASTICITY. D.D.Ivlev.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1321-4 (June 21, 1961). In Russian.

Isotropic bodies are considered whose deformations obey Hooke's law. A wide range of relationships is developed within the framework of accepted assumptions. [English translation in: Soviet Physics - Doklady (USA)]. J.K.Skwirzynski

14845 ELASTIC BEHAVIOUR OF DIAMOND. R.S.Krishnan, V.Chandrasekharan and E.S.Rajagopal.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 311-19 (May 26, 1960).

A simple discussion of the elastic behaviour of the diamond lattice is given leading to expressions for the elastic constants in terms of the interatomic force constants. Interesting variations in the nature and the magnitude of the interlattice displacements are elucidated in detail. A comparison of the theoretical values of the elastic constants with experimental observations lends strong support to the new 45-constant theory of crystal elasticity.

14846 ELECTRONIC EFFECT IN THE ELASTIC CONSTANTS OF GERMANIUM. L.J.Bruner and R.W.Keyes.

Phys. Rev. Letters (USA), Vol. 7, No. 2, 55-6 (July 15, 1961).

A 10 Mc/s ultrasonic pulse echo method was used to measure the elastic constants of pure and heavily doped Ge between 4.2° and 240°K. The values of C_{11} and C_{12} remained unchanged while C_{44} was found to be 5.5% smaller in the doped specimen than in the pure substance at 4.2°K. This behaviour is characterized as an electronic effect, and it is concluded that the change in C_{44} is caused by the addition of electrons to the conduction band. Small differences between the observed changes and those predicted theoretically are discussed. W.G.Mayer

14847 THE FLEXIONAL ELASTICITY OF THE NEMATIC PHASE OF AZOXYANISOLE. A.Saupe.

Z. Naturforsch. (Germany), Vol. 15a, No. 9, 815-22 (Sept., 1960).
In German.

The behaviour of homogeneous orientation (imposed by surface contact) of nematic layers in a magnetic field was investigated in the light of the theory of Frank (Abstr. 4348 of 1959) and applied to the determination of the (curvature) constants of azoxyanisole. The longitudinal and transverse constants were determined in parallel (to the layer plane) and in perpendicular oriented layers. The results for the two orientations differ considerably, supposedley due to indefiniteness in the conditions at the surface for the perpendicularly oriented layers. For the other orientation, experiment and theory are in good agreement. W.Good

14848 MEASUREMENT OF THE ELASTIC CONSTANTS OF LiF AND MgO AS A FUNCTION OF TEMPERATURE AND PRESSURE. C.Susse.

J. Rech. Cent. Nat. Rech. Sci. (France), No. 54, 23-59 (March, 1961).

Resonance measurements are described on samples of the cubic crystals LiF and MgO having different orientations. Pressures up to 1000 atm were used at temperatures over the range 20°-750° C for LiF and 20°-1200° C for MgO. The results are compared with those predicted for a cubic structure by Leibfried and Hahn; for LiF the agreement is satisfactory but for MgO it is less so. Some deficiencies in the theory are discussed. H.J.H.Starks

14849 CHANGE OF MECHANICAL CHARACTERISTICS OF AMORPHOUS SELENIUM UNDER THE ACTION OF GAMMA RAYS.

S.V.Starodubtsev, I.A.Domoryad and L.P.Khiznichenko.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 3, 594-5 (July 21, 1961).
In Russian.

When amorphous Se is irradiated by 700×10^3 r of gamma rays from Co^{60}, the shear modulus G increases by about 10% and the Q value drops by about 40%. On subsequent annealing at 25° C, G decreases by about 3% in the first 15 min and afterwards increases slightly. The results are briefly discussed in relation to the structure of amorphous Se. [English translation in: Soviet Physics—Doklady (USA)]. R.F.S.Hearmon

14850 DYNAMIC BEHAVIOUR OF POLYMETHYL METHACRYLATE BETWEEN 60 AND 300°K.

P.G.Bordoni, M.Nuovo and L.Verdini.
Nuovo Cimento (Italy), Vol. 20, No. 4, 667-93 (May 16, 1961).

The resonant frequency and the coefficient of energy dissipation were measured as a function of temperature in the interval (60-300)°K for several specimens of polymethyl methacrylate of the plasticized and unplasticized type. The specimens had shape of circular plates, and the measurements were made for flexural vibrations in the frequency range (6-40) kc/s, with a strain amplitude smaller than 10^{-7}. A thermally activated relaxation effect gives rise to a peak in the dissipation—temperature curve. For the above frequency range the temperature of the peak is about 110°K. At the same temperature a slight inflection is observed in the frequency—temperature curve in accordance with the theory of linear dynamic deformations. The relaxation effect, which is probably due to the rearrangement of side chains, is superposed to another cause of energy dissipation which cannot be explained by means of the above theory in its present state, as the corresponding dissipation coefficient increases not only with temperature but also with frequency. The frequency—temperature curve exhibits a knee near 230°K. This temperature is apparently independent of the vibration frequency, and the knee seems to be due to a second order transition.

14851 MECHANICAL DISPERSIONS AND TRANSITION PHENOMENA IN SEMICRYSTALLINE POLYMERS.

Y.Wada.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1126-34 (June, 1961).

The existing data of mechanical dispersions in seven semicrystalline polymers (polyethylene, polypropylene, polyethylene terephthalate, polytrifluoromonochloro ethylene, polyamide, polyurethane and polytetrafluoroethylene) are compiled and the frequency dependence of loss peak temperature ("transition map") is illustrated. The primary and secondary dispersions occurring in the amorphous regions are identified on the basis of these results. The correspondence of the mechanical to dielectric dispersions, transition temperatures found in dilatometric measurements and change in NMR line width with temperature is discussed for these polymers.

14852 CREATION OF HIGH TEMPERATURES BY INTE FRICTION. N.S.Fastov.

Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1069-72 (June 11, 19
In Russian.

Considers torsional vibrations of an isotropic metallic r
loaded at one end with a force-couple applied to its outside s
the other end is fixed. The results of analysis show that the
imum of internal friction (and temperature) corresponds to t
values of relaxation time for which the degree of relaxation i
compared to unity. [English translation in: Soviet Physics —
Doklady (USA)]. J.K.Skwi

14853 EFFECT OF OXYGEN IMPURITIES AND ALLOY ADDITIONS ON THE ELASTIC PROPERTIES AN INTERNAL FRICTION OF CHROMIUM.

I.H.Polot'skȳi, Z.L.Khodov and H.I.Levin.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 116-21 (1959). In Ukr

The results are presented of an investigation of the effec
oxygen impurities and alloying additions (Fe, Zr, Be) on the e
and inelastic properties of chromium and their dependence on
temperature. The minimum of the modulus of elasticity and t
anomalous change in the damping decrement on the curves re
senting the changes in the properties of chromium and its allo
with the temperature indicate the existence of low-temperatu
transformations in chromium and its alloys. The displaceme
the minimum of Young's modulus towards the lower temperat
on adding zirconium to chromium is evidence of the dependen
the temperature transformation on the alloying additions. An
increase in the oxygen content in chromium from 0.13 to 0.32
per cent causes a rise in the modulus of elasticity and a fall i
temperature at which there occurs a sharp increase in the dam
decrement. The decrease in Young's modulus of the chrome-
alloy indicates a weakening of interatomic bonds on adding iro
chromium. Addition of beryllium to chromium reinforces the
interatomic bonds. A sharp increase in the damping decreme
the temperature region of 450°-650° C is probably due to the
beginning of viscous sliding along the boundaries of the grains

14854 INTERNAL FRICTION IN LIGHTLY DEFORMED IRON WIRES. J.D.Fast and M.B.Verrijp.

Philips Res. Rep. (Netherlands), Vol. 16, No. 1, 51-65 (Feb., 1

The internal friction of pure (99.99%) iron wires was mea
before and after they had been subjected to a very small plasti
deformation. The damping after deformation is found to be str
dependent on amplitude, temperature deformation and tempera
of measurement. Wires subjected to deformation at temperatu
below -30° C show a spontaneous increase of internal friction,
deformed at temperatures above -30° C a spontaneous decreas
time goes on. In the latter case, plotting log Q^{-1} against t^p res
in straight lines provided that p is allotted values ranging fron
0.2 to 1.0 and differing for each experiment. By increasing the
vacancy concentration and the carbon content it is shown that d
sion of point defects toward dislocations is the process respon
for the spontaneous fall-off in damping. The phenomenon wher
damping increases with time is tentatively attributed to a dispe
of pile-ups of dislocations.

14855 THE EFFECT OF QUENCHING TEMPERATURE O THE NITROGEN PEAK OF INTERNAL FRICTION IRON. Yu.V.Piguzov and M.S.Blanter.

Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 6, 931-3 (Dec., 1960). In Russian.

At 22°C (0.8 c/s) an internal friction peak is observed in
α-iron due to deformation ordering of nitrogen atoms present
interstitial solid solution. The authors report the effect of que
temperature on this nitrogen peak. The absolute magnitude of
peak fell exponentially with increase of the quenching temperat
due to transitions of nitrogen atoms to vacancies. The energy
formation of vacancies in γ-iron was found to be 19 000 cal/mo
and the concentration of nitrogen in vacancies at the melting po
of iron was 0.05 at%. A.Tybul

14856 INTERNAL FRICTION AND DISLOCATION DENSIT AFTER PRELIMINARY PLASTIC DEFORMATION LiF. Yu.Kh.Vekilov, N.A.Tyapunina and M.P.Shaskol'skaya.

Kristallografiya (USSR), Vol. 5, No. 6, 953-5 (Nov.-Dec., 1960).
In Russian.

The quartz-oscillator resonance method was used to show
dependence of internal friction on the dislocation density. [Eng
translation in: Soviet Physics—Crystallography (USA), Vol. 5,
908-10 (May-June, 1961)]. R.F.

857 LOW TEMPERATURE INTERNAL FRICTION PEAKS IN SINGLE CRYSTALS OF NaCl AND LiF.

ylor.

pl. Phys. (USA), Vol. 32, No. 9, 1799-1800 (Sept., 1961).

The internal friction was measured for LiF and NaCl single :als in the temperature range 20° to 220°K at 40 and 6 kc/s; aled and deformed structures are compared. For NaCl a peak rs around 100°K, for LiF at 60°K in the case of deformed rials; the peak intensity increased with deformation and in ily deformed LiF there was evidence of the appearance of a nd peak. J.W.Taylor

858 INTERNAL FRICTION OF SYNTHETIC QUARTZ.

Y.Hiki.

ys. Soc. Japan, Vol. 16, No. 4, 664-70 (April, 1961).

Internal friction of 26 specimens of synthetic quartz was sured at room temperature using the composite oscillator iod. The specimens were cylinders, the axes of which lay in the tallographic YZ-plane and made various angles extending from to +40° with the Y-axis. Synthetic quartz usually had smaller es of the internal friction than natural quartz. The internal ion of specimens parallel or nearly parallel to the Y-axis was ost independent of the strain amplitude, while that of specimens ned to the axis at high angles showed noticeable amplitude-ndence. The orientation-dependence of the values of the inter-riction could be well explained by the theory of dislocation ping. The dislocation density in synthetic quartz was estimated 10^2-10^3 cm^{-2}, being about one hundredth of the density in ral crystals. The effect of X-irradiation on the internal friction artz was also studied for both synthetic and natural ones.

4859 FATIGUE OF INDIUM ANTIMONIDE.

R.E.Maringer and J.J.Duga.

metallurgica (Internat.), Vol. 9, No. 6, 617-18 (June, 1961).

Preliminary results for monocrystalline samples suggest that fatigue process is substantially the same as in engineering als. The straight-line relationship, with a slope of −0.5, is related with dislocation intersections and the crack formation dislocation pile-up. G.C.Williams

4860 CONTRIBUTION TO THE THEORY OF SMALL AMPLITUDE OSCILLATIONS.

G.I.Gurevich.

1. Akad.Nauk SSSR, Vol. 138, No. 6, 1313-16 (June 21, 1961).

ussian.

Propagation of small amplitude oscillations in metals, inorganic s, high polymers, etc., is characterized by practical independ-e of the logarithmic decay factor with respect to frequency. eral models of the microstructure of continuous media are dis-sed from the point of view of their effects on the propagation of ll oscillations, distinguishing between Hookean and non-Hookean rmations. J.K.Skwirzynski

4861 DYNAMIC MECHANICAL PROPERTIES OF STRETCHED NATURAL RUBBER.

E.R.Fitzgerald.

coust. Soc. Amer., Vol. 33, No. 10, 1305-14 (Oct., 1961).

Dynamic shear compliance measurements on a vulcanized ral rubber stock were carried out from 50 to 5000 c/s as a tion of static elongation in the range 0-400%. Above 300% gation several very large resonance dispersions appear in the ion 1000-2000 c/s, but at lower elongations no such resonances observed. The appearance of mechanical resonance dispersion coincides with the development of oriented crystallinity in the etched rubber as shown from X-ray diffraction data. On the other d, the magnitudes of the dispersions decrease with increasing ngation above 300% whereas X-ray measurements indicate the ount or extent of crystallinity increases with stretching above elongation. The resonances thus clearly decrease as the stallinity becomes more perfect or more extensive and hence ear to reflect the imperfections of the crystalline regions formed elongation rather than the crystallinity itself. Observed changes he compliance spectrum with time at each elongation also favour view. Broad retardation dispersions were observed when the ber was allowed to contract back to elongations below 300% after g times above 300%. These are tentatively ascribed to an ex-ded amorphous state in which the rubber molecules are kept tially extended by very small randomly oriented crystalline ions which persist for some time after retraction. Another in-esting feature of the results is an apparent correlation between percent crystallinity determined from X-ray diffraction and the iprocal of the general level of storage compliance 1/J' at quencies well below or well above the dispersion region.

14862 ON THE PLANE PROBLEM OF THERMOELASTICITY.

P.P.Teodorescu.

Acad. R.P. Romîne. Bul. Şti. Secţ. Şti. Mat. Fiz., Vol. 9, 471-9 (1957). In Romanian. With Russian and French summaries.

The author studies thermoelastic stress distribution in the interior of a homogeneous and isotropic body. Two cases are dealt with in particular, namely, (a) the temperature distribution, T(x,y), is known inside the body, and (b) the function T(x,y) satisfies the heat equation. He also indicates some boundary-conditions that should be satisfied by the appropriate stress-functions, as well as some methods of approximate analysis. It should be noted, however, that the author does not present any proofs as to whether these boundary conditions are compatible. Existence and uniqueness theorems are not stated. Mathematical Reviews (K.Bhagwandin)

14863 ON A COMPLEMENTARY ENERGY PRINCIPLE IN LINEAR THERMOELASTICITY.

G.Herrmann.

J. Aero. Sci., Vol. 25, 660 (1958).

The author uses the formulation of linear thermoelasticity proposed by Biot (Abstr. 6577 of 1956). He shows that, if two of the four basic equations are assumed, the other two are the Euler equations of a certain variational integral with respect to variations of the stress and the temperature. The assumed two equations correspond to Cauchy's law of mechanical equilibrium and Fourier's law of heat conduction. The derived two equations correspond to the stress-strain law and the law relating entropy, temperature, and stress. The variational theorem of the author generalizes the classical theorem of Castigliano.

Mathematical Reviews (W.Noll)

14864 DEPENDENCE OF THE COMPRESSION CURVE PARAMETERS OF SINGLE-CRYSTAL GERMANIUM ON TEMPERATURE AND STRAIN VELOCITY.

V.G.Govorkov and V.R.Regel'.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1324-30 (May, 1961). In Russian.

Compressive stress—strain curves are measured for germanium single crystals of three orientations at temperatures between 20 and 900°C and at strain rates between 10^{-2} and 10^{-6} sec^{-1}. The stress—strain curves may pass through a sharp maximum before the onset of creep, and the conditions under which these flow "teeth" arise is investigated. Activation energies are also discussed. [English translation in: Soviet Physics—Solid State (USA)].

R.F.S.Hearmon

14865 STRAIN IN CRYSTALS OF YTTRIUM IRON GARNET.

A.W.Smith and G.W.Williams.

Canad. J. Phys., Vol. 39, No. 5, 768-73 (May, 1961).

In a previous paper, (Abstr. 16141 of 1960) the authors pointed out that an unusual type of strain occurs near (112) growth faces of yttrium iron garnet ($Y_3Fe_5O_{12}$) prepared in the form of small crystals by growth from a melt. The strain axis, which is a direction of easy magnetization, is inclined to the growth face, and appears to be introduced during the growth of the crystals. This is to be contrasted with the strain which is often introduced during grinding of the crystals, and results in a strain axis perpendicular to the ground surface. The magnetic strain anisotropy of the (112) growth face strain was investigated by means of ferromagnetic resonance on a disk whose surface is a (112) plane. The disk is optically transparent and the optical birefringence was investigated with a polarizing microscope. The magnetic and optical anisotropy due to the strain were correlated by considering the magnetoelastic and photoelastic interactions. An explanation of the magnetic birefringence is proposed in terms of the magnetostrictive and photoelastic effects. P.E.Seiden

14866 APPLICATION OF THE THREE-PARAMETER STRESS FUNCTION TO NATURAL RUBBERS OF WIDELY DIFFERENT HARDNESS.

A.J.Carmichael and H.W.Holdaway.

J. appl. Phys. (USA), Vol. 32, No. 9, 1724-8 (Sept., 1961).

The previously reported three-parameter stress function (Abstr. 3965 of 1961) has been applied to natural rubbers similar to those used for engineering purposes. These rubbers were selected to cover a hardness range from 30 to 80 British Standard Degrees. A suitable choice of values for the parameters A, B, and β was found to give a good description of the stress—strain characteristics in pure shear, and positive and negative stretch squeeze. This agreement applied up to the maximum possible strains. Unique relationships were found to exist between the three parameters and rubber hardness. Theoretically, it should be possible to reduce the three-parameter stress function to a single-parameter stress function.

14867 ELASTICITY OF POLYMER NETWORKS CROSS-LINKED IN STATES OF STRAIN. P.J.Flory.

Trans Faraday Soc. (GB), Vol. 56, Pt 5, 722-43 (May, 1960).

The theory of elasticity of composite network [Berry, Scanlan and Watson, ibid., Vol. 52, 1137 (1956)], formed by introducing $\nu_1/2$ cross linkages in a state of isotropy and $\nu_1/2$ in a state of deformation λ_1 is generalized to apply to any subsequent deformation λ_2 (taken relative to state λ_1) whatever, the deformation gradient matrices λ_2 and λ_1 being unrelated. Irrespective of the distribution of cross-linked units, the elastic free energy assumes the form for two independent networks: $\Delta F_{el} = (kT/2)[\nu_1 I + \nu_2 I_2 - (\nu_1 + \nu_2) \ln (V/V_0)]$, where I and I_2 are first invariants of the relevant matrices, i.e., $I = \mathrm{Tr}(\tilde{\lambda}\lambda - E)$, with $\lambda = \lambda_2\lambda_1$ and $I_2 = \mathrm{Tr}(\tilde{\lambda}_2\lambda_2 - E)$, E being the unit matrix; V and V_0 are the volume and reference volume respectively. The composite network is elastically isotropic with respect to its equilibrium state of ease (null stress), as found by Berry, Scanlan and Watson. If some or all of the first set of cross linkages are removed subsequent to introduction of the second set, the latter contribute to the strain free energy as though a portion of them were members of the first set. The actual residual number ν_1 of the first set of chains must then be replaced in the elastic free energy expression by the effective number $\nu_{1e} = \nu_1 + \Phi\nu_2$, where Φ is given as a function of ν_1, ν_2 and the number ν_1^0 removed; ν_2 is replaced by $\nu_{2e} = \nu_2 - \Phi\nu_2$. Thus, the required revision amounts to transfer of chains between categories. Indiscriminate removal of cross linkages from a composite network alters the dimensions in the state of ease, thereby revealing a residual anisotropy not otherwise apparent in the elastic properties relative to the state of ease. Simultaneous formation and destruction of cross linkages in a state of strain is treated by an intuitive extension of the preceding analysis of the consequences of these processes when they occur in discrete stages. Relevance to stress relaxation, brought about by reorganization either of the chemical structure or of the often-postulated physical cross linkages, is discussed. Non-exponential decay of stress is predicted for concurrent rupture and (independent) re-formation of cross linkages, the total number remaining constant.

14868 RECRYSTALLIZATION OF THE STRETCHED IRON SINGLE CRYSTAL PLATES. S.Dohi.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 313-25 (Oct., 1960).

Iron single crystals of two basically different orientations were subject to tensile straining so that one group underwent double slip on the $(\bar{1}01)/[111]$ and $(101)/[\bar{1}11]$ systems and the other by single slip on the $(\bar{1}0\bar{1})/[111]$ system; subsequent recrystallization was effected at 700°-900° C. Texture and crystallographic form was studied as stretched and after annealing. It is concluded that recrystallization nuclei generate only in deformation bands, the orientation of the single crystals produced being close to that of the deformation band or the deformed matrix. J.W.Taylor

14869 DEFORMATION TWINS BY TENSILE IMPACT IN WHITE TIN. T.Hirokawa.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 637-45 (Dec., 1960).

Forty-one single crystal plates of white tin were prepared by Fujiwara's method. The crystallographic orientations in their lengthwise directions were so made as to be distributed somewhat uniformly in a stereogram. These specimens were pulled by impact and then observed with an ordinary microscope. The results showed the correspondence of the behaviours of formed twins with the crystallographic orientations in the directions of impact. The formed twins were mainly (301) twins, and in some of the specimens, the crystallographic orientations of which in the direction of impact were in the limited range on a stereogram, somewhat wide (101) twins were formed separately from the (310) twins. The crystallographic orientations in the direction of the impact in which (301) twins were easily formed, were limited to the range about 1/4 on a stereogram, and in the most part in this range, (301) twins on the different kinds of the (301) plane, i.e., (301), (031), $(0\bar{3}1)$ and $(\bar{3}01)$ planes, were formed together, and the range in which a twin on a single kind of the (301) plane was formed, was limited. It was determined that the expended energy on a twinning place in the twinning direction to form a (301) twin was about 7×10^5 erg/cm² or less. The results are compared with those obtained from similarly prepared specimens subjected to compressive impact.

14870 PHYSICAL PROPERTIES OF TITANIUM NITRID THE HOMOGENEOUS REGION.

G.V.Samsonov and T.S.Verkhoglyadova.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 2, 342-3 (May 11, 1961)
In Russian.

The concentration dependence of microhardness and elec
resistivity, ρ, of TiN was determined for that range of compo
(35-50 at.-% N) in which TiN exists as a single phase of the s
tutional type. The temperature dependence of ρ of TiN with va
N contents was also determined. The results indicated that,
contrast to Ti and Zr carbides where the electron structure,
chemical bond, and electron density distribution in the lattice
basically similar to those obtained in metals, the chemical bo
TiN is more ionic in nature, the part played by the ionic bond
increasing with decreasing N content. A similar effect was p
dicted for nitrides of other transition metals (Zr, Hf, V) whos
atoms are characterized by high acceptor capacity of the d-el
level. [English translation in: Soviet Physics—Doklady (USA
M.H.S

ELASTIC DEFORMATION AND THERMAL EXPANSION.

See Abstr. 14186

14871 THE KINETICS OF THE INSTANTANEOUS ELAS DEFORMATION OF POLYMERS IN THE ELASTI STATE. L.V.Ivanova, V.F.Chuvaev and P.A.Rebinder.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 83-6 (July 1, 1961).
In Russian.

The response of polyisobutylene of different molecular
weights to stress is recorded oscillographically, and the resu
are interpreted in terms of a modified Kelvin relationship.
[English translation in: Soviet Physics - Doklady (USA)].
R.F.S.He

14872 NON-UNIFORMITY OF PLASTIC DEFORMATION TENSION. B.M.Strunin.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 751-7 (May, 1960). In Russian.

The magnitude of the mean quadratic deviation of elongati
$g(\epsilon)$, is taken as a measure of the degree of non-uniformity of
deformation, and the method of statistical analysis is used to
expressions relating the gauge length, l_0, of a tensile test-piece
the degree of dispersion of elongation on l_0. The theoretical f
is in good agreement with the experimental results obtained b
author and by Rybalko (Izvestiya Vysshikh Uchebnykh Zaveden
Fizika, 1959, No. 1, 6). The relationship between $g(\epsilon)$ and the
deformation of a test-piece was experimentally determined.
M.H.S

14873 THE DYNAMIC PLANE DEFORMATION OF AN II PLASTIC—RIGID SOLID. A.J.M.Spencer.

J. Mech. Phys. Solids (GB), Vol. 8, No. 4, 262-79 (Nov., 1960)

This paper is concerned with the motion under plane stra
conditions of an ideal plastic—rigid solid, when the inertial fo
are not negligible. It is shown that the equations for such a m
can be expressed in a particularly simple form when referred
system of moving curvilinear coordinates which is a generaliz
of the system defined by the slip-line field in quasi-static plan
plasticity. A perturbation method of solving the equations is
described; in this, approximate solutions to dynamic problems
obtained as perturbations of a known (usually quasi-static) sol
The method is illustrated by application to problems of indenta
of a plastic—rigid half-space by stationary and moving loads.

14874 DEFORMATION OF ROCK SALT CRYSTALS AT ELEVATED TEMPERATURE.

M.V.Klassen-Neklyudova and A.A.Urusovskaya.
Kristallografiya (USSR), Vol. 5, No. 5 744-8 (Sept.-Oct., 1960
In Russian.

NaCl crystals were compressed rapidly at 500-600° C or
deformed at 20° C and then subjected to long-continued heating
is shown that in both cases the reoriented regions are recryst
tion grains. In the first case, the rate of growth of a grain is
approximately 200 times greater than in the second case. The
supposition that mechanical twinning at NaCl crystals at high
temperatures is possible according to the spinel law was not
confirmed. [English translation in: Soviet Physics — Crystall
(USA), Vol. 5, No. 5, 709-14 (March-April, 1961)].

875 STRESS FIELD IN METALS AT INITIAL STAGE OF PLASTIC DEFORMATION.
in, S.Uchiyama and D.Martin.
ch. Phys. Solids (GB), Vol. 9, No. 3, 200-9 (July, 1961).

The initial stage of plastic deformation of a fine grained gate with slip occurring only in the most favourably oriented als is studied. The elastic modulus of the individual crystals en to be isotropic. The sliding crystals are assumed to be al in shape and located at the interior of the aggregate. Work-ening in the sliding crystal is considered. The analogy of ic strain gradient and body force in producing stress field elastic medium is developed. This analogy is applied to late the slip and stress fields caused by (1) one sliding crystal 2) two sliding crystals spaced at a clear distance of half the al width. This shows the interaction effect of slips in two oy crystals. From these stress fields, the residual stress be easily obtained and the Bauschinger effect is clearly shown.

876 THE EFFECT OF θ' PHASE ON THE PLASTIC DEFORMATION OF AN AGE-HARDENABLE Al—Cu LLOY. K.Matsuura and S.Koda.
ys. Soc. Japan, Vol. 15, No. 10, 1905-6 (Oct., 1960).

877 THE EFFECT OF PLASTIC DEFORMATION ON THE CLUSTER FORMATION IN AN Al—Cu 4 % ALLOY.
tsuura and S.Koda.
ys. Soc. Japan, Vol. 15, No. 11, 2106-7 (Nov., 1960).

Polycrystalline specimens were either water-quenched or cooled after solution treatment at 520°-530°C, and immediately they were immersed in liquid nitrogen. The specimens were rmed at this temperature to various extents (0-18%) before transferred to a bath for ageing (18° to -30°C). The ageing ess was investigated by making resistivity measurements at vals at liquid nitrogen temperature. With material which had given little deformation the resistivity increased rapidly initial-d then the rate fell towards zero as ageing proceeded, where-r large deformations ($\sim 13\%$) an initial drop preceded the more ral rise in the resistivity. Plastic deformation increased the of rise of the resistivity in the early stages of ageing and uced a more rapid fall-off. It is suggested that the former t is due to the excess vacancies produced by deformation e the latter is caused by the increase in dislocation density, islocations acting as sinks for the vacancies. A.E.Kay

878 PREFERENTIAL PLASTIC DEFORMATION IN THE SURFACE REGION OF Al AND α-Fe SINGLE STALS. K.Sumino and M.Yamamoto.
hys. Soc. Japan, Vol. 16, No. 1, 131 (Jan., 1961).

Limited data are outlined on the differences in degree of -hardening in the surface and interior regions of Al and α-Fe le crystals. For Al the resolved shear stress after deformation .38 and 24.6% strain is lowered after removal of 150-190 μ of ace by electrolytic polishing. For α-Fe, evidence of increased ocation density at the surface is suggested from a difference eform of Laue spots from back-reflection studies.

J.W.Taylor

EFFECT OF PLASTIC DEFORMATION ON RESISTIVITY OF D—PALLADIUM ALLOYS. See Abstr.14360

4879 PLASTIC DEFORMATION OF Zn MONOCRYSTALS UNDER CONDITIONS PREVENTING BASAL SLIP. EFORMATION CURVES. V.R.Regel' and V.G.Govorkov.
stallografiya (USSR), Vol. 4, No. 6, 878-86 (Nov.-Dec., 1959).
ussian.

Two orientations in which basal slip is impossible were used xamine the effects of temperature and deformation rate on the pression curves of Zn monocrystals containing varying unts of Cd. Specimens having their axes parallel to the basal e give the equation of state proposed by Gilman (1956) for peratures above 250°C. Specimens whose axes are normal to plane do not obey that equation. The deformation mechanism be established from the compression curves and the final shape he specimen. [English translation in: Soviet Physics — stallography (USA), Vol. 4, No. 6, 832-9 (June, 1960)].

14880 PLASTIC DEFORMATION OF Zn MONOCRYSTALS UNDER CONDITIONS PREVENTING BASAL SLIP. DISLOCATION DISTRIBUTION IN SPECIMENS, THE DIRECTION COMPRESSION OF WHICH LIES IN THE BASAL PLANE.
.Urusovskaya and V.M.Stepanova.
stallografiya (USSR), Vol. 5, No. 6, 924-31 (Nov.-Dec., 1960).

Crystals subjected to compression along the basal plane at 20°, 100°, 200°, and 300° C were studied by the method of selective etching and by means of Laue back-reflection diffraction patterns. [English translation in: Soviet Physics — Crystallography (USA), Vol. 5, No. 6 879-88 (May-June, 1961)].

14881 ROLLING DEFORMATION AND RECRYSTALLIZATION IN ALUMINIUM SINGLE CRYSTAL PLATES. Y.Takano.
J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 297-312 (Oct., 1960).

A study was made of the roll and recrystallization textures of six Al single crystals of different initial orientations, prepared by a strain/anneal technique; rolling reductions were by 10% stages up to a maximum of 90% and recrystallization was effected at 400°-600°C. From Laue X-ray photographs, an assessment is made of residual roll texture, recrystallized grain size, and the degree of perfection of the crystal structure after various annealing treatments; the inter-relationship of recrystallized to original orientation is established. [The conclusions reached are largely qualitative. The presentation is obscure in many places; many low-quality X-ray prints are reproduced]. J.W.Taylor

14882 THE MECHANICAL TESTING OF HIGH POLYMERS. H.Kolsky.
Progress in non-destructive testing, Vol. 2 (see Abstr. 9239 of 1961) p. 27-59.

The theory of viscoelastic behaviour is considered, and experimental methods for study of creep and stress relaxation, forced oscillations, resonance and wave propagation in polymer specimens are described. Further sections discuss behaviour with non-sinusoidal loading, hardness measurements and temperature effects. 56 references. J.B.Birks

14883 GRAIN BOUNDARY ADSORPTION AND "SUPERHIGH PLASTICITY". M.G.Lozinsky.
Acta metallurgica (Internat.), Vol. 9, No. 7, 689-94 (July, 1961).

New experimental data on the influence of adsorption of impurities by grain boundaries in iron, titanium and zirconium on the development of "superhigh plasticity" under cyclic fluctuations of temperature are described. The factors are explained which result in formation of two necks in the specimens undergoing tension and heating. The tentative evaluation of carbon concentration in the grain boundary of technical iron is given. Further investigations on the factors leading to "superhigh plasticity" in metals and alloys and experimental determination of "danger" temperature intervals, within which rapid loss of strength takes place, are necessary as these are of theoretical interest and may be important for practical application.

14884 THERMORHEOLOGICAL SIMPLICITY IN EXTRUSION FLOW CURVES OF HIGH POLYMERS. K.Ito.
J. appl. Phys. (USA), Vol. 32, No. 9, 1743-5 (Sept., 1961).

Thermorheological simplicity is available for the extrusion flow curves of polymers in a way similar to the case of creep or stress relaxation. The true consistency curves for acrylic resin which were obtained from the extrusion flow curves at various extrusion temperatures by the help of the end-correction factor ξ are superimposed by shifting along the log D_W' (where D_W' is apparent maximum shear rate at the die wall). Thus the consistency curves by extrusion which are useful for evaluating the viscoelastic behaviour of amorphous linear polymers can easily be determined over a sufficiently wide range of shear rates by the change of extrusion temperature.

14885 EVOLUTION OF SOME PHYSICAL PROPERTIES OF VULCANIZED RUBBER IN ITS FLUIDIFYING DEGRADATION. J.C.Danjard.
Ann. Phys. (France), Vol. 6, No. 1-2, 81-123 (Jan.-Feb., 1961).
In French.

Several physical methods were used to study the process of the fluidifying degradation of rubber; this phenomenon, characterized first by surface tackiness, spreads rapidly throughout the whole material. Thus, fluidification can be considered a kind of reversion to the plastic state, when the structures are obviously quite different from those found in non-vulcanized rubber. F.Lachman

14886 SOME PARTICULAR SOLUTIONS OF THE EQUATIONS OF THE AXIALLY SYMMETRICAL PROBLEM OF THE THEORY OF IDEAL PLASTICITY AND A GENERALIZATION OF THE PRANDTL SOLUTION FOR THE COMPRESSION OF A PLASTIC LAYER BY TWO ROUGH PLATES. D.D.Ivlev.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 5, 673-8 (1958).
In Russian.

Some particular solutions are derived for the axially symmetrical problem of ideal plasticity, corresponding to the Mises and Tresca—Saint-Venant plasticity conditions. Application is made to the problem of the compression of a plastic layer between rough coaxial cylindrical surfaces. R.F.S.Hearmon

14887 ON SIZE EFFECTS IN POLYCRYSTAL PLASTICITY.

R.W.Armstrong.

J. Mech. Phys. Solids (GB), Vol. 9, No. 3, 196-9 (July, 1961).

Two cumulative "size" effects are responsible for the increased strength of a polycrystalline aggregate above the single crystal strength at low temperatures: a "specimen size" effect and a "grain size" effect. The "specimen size" effect occurs when few grains are present in a specimen cross-section (say less than twenty), and this effect is due mainly to the orientation dependence of crystal plastic flow. The "grain size" effect occurs when many grains are in a specimen cross-section (say more than twenty), and this effect results because, in addition to the orientation dependence of plastic flow within grains, internal concentrations of stress are necessary at grain boundaries to cause bulk yielding and subsequent plastic flow of the polycrystalline aggregate.

14888 ELASTIC-PLASTIC TRANSITION IN COPPER CRYSTALS AS DETERMINED BY AN ETCH-PIT TECHNIQUE.

F.W.Young, Jr.

J. appl. Phys. (USA), Vol. 32, No. 10, 1815-20 (Oct., 1961).

Copper (99.999%) crystals with a dislocation density of $50/\text{mm}^2$ were prepared, stressed by applying a pure bending moment, and were etched with a dislocation etch either before and after or while the stress was applied. The motion of dislocations was determined by observing the size and nature of the dislocation etch pits. The resolved stress necessary to move grown-in dislocations was about $4\ \text{g}/\text{mm}^2$. Dislocation motion under stress, followed by return motion when the stress was removed, and multiple motion under stress were observed. Multiplication of dislocations occured at a resolved stress of about $18\ \text{g}/\text{mm}^2$. The observed phenomena are discussed in terms of simple dislocation theory.

STRIPE PATTERN DURING ROLLING OF VISCOUS MATERIALS. See Abstr. 12844

DISLOCATION DENSITY AND FLOW STRESS OF SODIUM CHLORIDE. See Abstr. 14287

MOLECULAR-WEIGHT DEPENDENCE OF THE VISCOELASTIC PROPERTIES OF WHOLE POLYMERS. See Abstr. 14134

14889 THE RHEOLOGICAL BEHAVIOR AND THIXOTROPY OF A FATTY PLASTIC BODY.

T.Sone.

J. Phys. Soc. Japan, Vol. 16, No. 5, 961-71 (May, 1961).

A fatty plastic body such as butter or margarine possesses the remarkable non-Newtonian character in its rheological properties. The quantitative study of the viscosity, elasticity and yield value of butter was performed under various conditions of temperature and shearing stress. The apparatus employed in the measurements involve an oscillating plate viscometer, a cone-plate viscometer and a parallel plate plastometer. The viscosity, elasticity and yield value decrease remarkably when the specimen is subjected to the kneading on the roll mill, but they recover gradually to their original values after setting the specimen for a long time. The volume dilatometry of the specimen was also carried out continuously for a setting period of two months. From the comparison of results, the magnitude of viscosity or yield value of butter could be successfully connected to the degree of crystallization of fat in butter which had been evaluated from the specific volume of the specimen. The origin of the thixotropic softening and hardening of butter should be sought for, therefore, in the mechanism of rupture and formation of the three dimensional network of fat crystals in the specimen.

14890 PLASTIC YIELDING IN ANELASTICITY.

M.Reiner.

J. Mech. Phys. Solids (GB), Vol. 8, No. 4, 255-61 (Nov., 1960).

By means of the application of a yield criterion, according to which yielding takes place when that part of the stress-work which is conserved reaches a definite maximum value, it is shown that from the constitutive equation of anelasticity two phenomena follow. On one hand, when the load is constant, yielding can take place after some time in creep. On the other hand, when a constant rate of strain is applied, the yield stress increases with the rate of strain.

14891 THE MECHANISM OF KINKING.

M.V.Klassen-Neklyudova, M.A.Chernysheva and G.E.Tomilovskii.

Kristallografiya (USSR), Vol. 5, No. 5, 646-9 (July-Aug., 1960
In Russian.

High-speed cinephotography (up to 5000 frames/sec) was
to study kinking in crystals of caesium iodide and naphthalene
compression. Kinking is due to the loss of plastic stability bu
elastic stability. The appearance of a kink is preceded by an
abrupt stress redistribution. Slip in the kink band always occ
a direction opposite to that of the preceding plastic deformati
[English translation in: Soviet Physics — Crystallography (US
Vol. 5, No. 4, 617-20 (Jan.-Feb., 1961)].

14892 THE MECHANISM OF THE PROCESSES OF STAT TENSION, CREEP AND RELAXATION.

J.Wantuchowski.

Bull. Acad. Polon. Sci. Ser. Sci. tech., Vol. 8, No. 3, 115-22 (

Discusses relaxation effects in "soft" mechanical testing
machines. H.M

14893 SUBSTRUCTURE FORMATION IN IRON DURING CREEP AT 600° C.

F.Garofalo, L.Zwell, A.S.Keh and S.Weissmann.

Acta metallurgica (Internat.), Vol. 9, No. 8, 721-9 (Aug., 1961

Structural changes in iron during creep at 600° C under c
stresses of 176 and 550 kg/cm^2 were investigated by means of
several different techniques. These techniques include metall
graphic examination, high-resolution X-ray methods and trans
mission electron microscopy. Quantitative measurements sho
that with increasing creep strain the subgrain size remains co
stant but the disorientation between subgrains increases and t
lattice misorientation within the subgrains decreases. No pile
groups of dislocations are observed. Gross grain deformation
accounts for about 25-30% of the overall strain. This finding
indicates that grain-boundary shearing is a prominent deforma
mode for iron under the conditions of temperature and strain
investigated. Extensive void formation in grain boundaries is
and is attributed to the predominance of grain-boundary shear

14894 EFFECT OF HYDROSTATIC PRESSURE ON THE HIGH-TEMPERATURE STEADY-STATE CREEP C LEAD.

B.M.Butcher and A.L.Ruoff.

J. appl. Phys. (USA), Vol. 32, No. 10, 2036-8 (Oct., 1961).

The activation energy and activation volume for the creep
high-purity lead were obtained by the method of rapidly varyin
temperature and pressure. The activation energy was found t
1.18 ± 0.03 eV and the activation volume to be (24.2 ± 0.6) × 1
cm^3 or 0.80 atomic volume.

14895 A STUDY OF THE STRUCTURAL CHANGE OF NICKEL DURING CREEP.

H.Ya.Kozÿrs'kÿi, V.A.Kononenko and P.M.Okrainets'.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 391-6 (1958). In Ukrai

An X-ray procedure was worked out for studying structur
changes in grains of coarse crystal line materials during cree
The application of this method to the investigation of creep in
nickel at a temperature of 500°C and a load of 5 kg/mm^2 helpe
reveal the peculiarity of the structural changes during the first
second stages of creep. It was shown that at the first stage gr
crushing begins immediately after loading the specimen. The
crushing of the grains and the increase in their mosaic angles
particularly intensive at the beginning of the test. These proc
go on at a more rapid rate in large grains than in small grains
the second stage, grain crushing and increase in the mosaic an
go on less intensively. Deformation proceeds, chiefly, as a vi
flow along the grain boundaries and by formation of subgrain
elements and their mutual rotation. The grains themselves tu
respect to each other at angles of the order of 3°. Due to the
movement of the grains the surface of the specimen becomes s
and cracks are formed, along which the destruction of the spec
takes place.

14896 THE FLOW STRESS OF GERMANIUM CRYSTALS.

H.G.van Bueren.

Physica (Netherlands), Vol. 26, No. 11, 997-9 (Nov., 1960).

This is an extension of previous theoretical work (Abstr..
of 1960) on the stationary creep of homopolar material. The p
cular feature of the analysis is the derivation of the temperatu
dependence of the activation volume associated with the resolv

stress acting on the operating glide systems. This leads to esult that the resolved shear stress should be an exponential on of temperature and directly proportional to the logarithm strain rate. Both these results are apparently in agreement some unpublished observations of Haasen and Alexander.

R.Bullough

897 DEFORMATION, HEATING AND MELTING OF SOLIDS IN HIGH-SPEED FRICTION.

Bowden and P.A.Persson.

. Roy. Soc. A (GB), Vol. 260, 433-58 (March 21, 1961).

An experimental study has been made of the effects of frictional ng on the deformation of solids rubbing at very high speeds and asonably heavy loads. A new method for measuring the friction r these conditions is described. A steel ball, rapidly spinning d its vertical axis, is allowed to fall a short distance and to ce off an inclined flat solid surface. The friction of steel on ous solids in a vacuum of ~ 10^{-4} mm Hg, at sliding speeds up 0 m/s, is determined from the measured direction of the ball's zontal velocity after the impact. In addition, separate piezo-tric measurements are made of the load and the friction force. n the coefficient of friction is found to decrease with increasing ng speed. The general behaviour is similar to that observed at loads but there are important differences. With heavy loads leformation of the solids appears to be primarily plastic. Within very short time after being brought into contact with a fast-ing surface, solids with a sufficiently low melting point melt on ge scale so that a continuous film of molten material is developed over the area of contact. The resistance to motion is determined primiarly by this liquid film so that it may now increase as speed rises. The heating due to the shearing of this film causes solid to melt away rapidly, and as a result the wear rate of such is usually becomes great at high sliding speeds. Certain mers, however, exhibit a greater wear resistance than metals other solids which possess a low viscosity in the molten state. ulations indicate that in these polymers, owing to their high visty, the temperature of the sheared film may be considerably er than the melting temperature. As a consequence, a larger ortion of the heat developed by the shearing may be absorbed in already molten material, and less heat will be available for ner melting. Gas liberated by thermal decomposition may also ice the friction and wear.

4898 THE MECHANISM OF SURFACE EFFECTS IN CRYSTAL PLASTICITY. J.J.Gilman.

. Mag. (GB), Vol. 6, 159-61 (Jan., 1961).

The paper outlines an interpretation of the effect of surface s, solid and liquid, on the stress/strain curves of plastic ocrystals. It is based on a "cross-glide" motion whereby the ocation length is reduced; this motion is opposed by the surface gy of the step produced and hence the effect of solid and liquid s is explained. Other features the theory is said to explain ide the major effect of such films on plastic rather than elastic in, the occurrence of an optimum strain-rate effect, glide e orientation effects, irregular glide bands, etc.

J.W.Taylor

14899 THE FLOW STRESS OF ALUMINIUM AND COPPER AT HIGH TEMPERATURES.

.Hirsch and D.H.Warrington.

.. Mag. (GB), Vol. 6, 735-68 (June, 1961).

The ratio of the flow stress at a high temperature to that at was measured for polycrystalline Al and Cu, and for single stals of Al. In Al the flow stress ratio decreases strongly with perature above a certain critical temperature (about 250° C). u a similar but more gradual decrease in the flow stress ratio bserved. The results are interpreted in terms of a model ed on sessile vacancy jogs in screw dislocations, which has also n used by Hirsch (1960) and Mott (1960) to explain linear dening. Below a certain critical temperature the screw dislo-ons advance with the aid of stress leaving a dipole or a row of ancies behind; in this region the flow stress will be nearly perature independent. Above the critical temperature the jogs ance with the aid of thermal activation, vacancies being emitted and moving away from the jogs in the same thermally activated cess, and the flow stress decreases strongly with temperature. activation energy for this process is that of self-diffusion. analysis of the experimental results in terms of this model ws that the mean vacancy jog height for Al is 2-5 Burgers tors, and for Cu only 1-2 Burgers vectors. Models involving climb of edge dislocations are also discussed and found to be satisfactory, although they cannot be ruled out completely.

14900 EVIDENCE OF SUB-SURFACE CROSS-SLIP IN FATIGUED COPPER.

A.H.Meleka, W.Barr and A.A.Baker.

Phil. Mag. (GB), Vol. 6, 315-16 (Feb., 1961).

Evidence from fine electropolishing of fatigued copper, followed by progressive penetration into the surface of cross-slip in those slip bands which eventually lead to crack formation, is presented and found to lend support to the ideas put forward by Mott (1958).

C.A.Hogarth

14901 SOME OBSERVATIONS ON PLASTIC DEFORMATION AND SLIP LINES OF SODIUM CHLORIDE WHISKER.

K.Kamiyoshi and T.Yamakami.

J. Phys. Soc. Japan, Vol. 15, No. 7, 1347 (July, 1960).

Measurements of the tensile strength of NaCl whiskers were made. Whiskers of small diameter ($< 10^{-3}$ mm^2) had high yield strengths and exhibited brittle fracture; for larger diameter whiskers the yield strength dropped but large plastic deformation occurred; with still larger diameters, the whiskers had normal bulk-crystal properties with low yield strength and small plastic deformation. Slip usually occurred on the single set of (110) plane systems.

J.Franks

14902 TENSILE STRAINING AND DEFORMATION BANDS OF SINGLE CRYSTAL OF PURE IRON. S.Dohi.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 1, 97-106 (July, 1960).

The shear stress—strain curve obtained after deformation by single slip is about 5% different from that obtained after deformation by double slip. Deformation bands appear after single slip, a typical one being formed by single slip with an angle between the slip direction and the observed surface less than 30°, the shear strain being 0.3. The results are illustrated by X-ray diffraction data and by photomicrographs.

C.A.Hogarth

14903 SLIPPING AND TWIN BANDS IN THE CRYSTALS OF WHITE TIN. T.Hirokawa.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 2, 339-57 (Oct., 1960).

Electron and optical microscopy was used in conjunction with interferometric and etching techniques to study the effect of Cu precipitates on the movement of twin planes and the resulting slip planes in single crystals of Sn under tensile stress.

R.F.Peart

14904 NON-BASAL SLIP AND TWIN ACCOMMODATION IN ZINC CRYSTALS. H.S.Rosenbaum.

Acta metallurgica (Internat.), Vol. 9, No. 8, 742-8 (Aug., 1961).

An etch pit technique was used to observe dislocation patterns on the basal plane of zinc moncrystals. It was confirmed that at room temperature non-basal slip occurs on the $\{11\bar{2}2\}$ pyramidal planes. Observations were made on $\{10\bar{1}2\}$ mechanical twins that go partially through the crystal. Such twins often terminated in a group of slip bands at 90° and 30° to the twin trace; the orientation of these slip bands is consistent with pyramidal slip. At other twins a row of dislocations emanates from the tip; these dislocations lie on the $\{10\bar{1}2\}$ twin habit planes. When a crystal is annealed, the twins tend to become parallel-sided, and they recede leaving a trail of dislocations in the matrix crystal.

14905 HIGH TEMPERATURE DEFORMATION OF ALUMINUM SINGLE CRYSTALS. S.Howe, B.Liebmann and K.Lücke.

Acta metallurgica (Internat.), Vol. 9, No. 7, 625-31 (July, 1961).

The temperature and strain-rate dependence of work hardening in aluminium crystals was investigated with special attention to the high-temperature range. Single crystals of high-purity aluminum were grown and extended at various temperatures and strain rates. It has been found that above 550°K the yield point drops rapidly with temperature and the easy glide region of the stress—strain curve lengthens. These results show that the mechanism of work hardening at high temperature is quite different from that at low temperatures, and the differences are unexplained by current theories.

14906 STORED ENERGY MEASUREMENTS ON COPPER AND NICKEL COLD WORKED AT LIQUID NITROGEN TEMPERATURE. A.van den Beukel.

Physica (Netherlands), Vol. 27, No. 6, 603-5 (June, 1961).

Measurements using a differential calorimeter were made on specimens of Ni and Cu as they were heated up from 90° - 300° K at a rate of 0.5 deg. K/min after being plastically deformed at 78°K. The results show that this stage of recovery, the second of five associated with deformation and irradiation, has a fine structure involving three sub-stages and in addition an extra stage was found to precede stage III. The similarity between the centre temperatures of stage II for Ni and Cu when measured on a reduced (with respect to melting point) temperature scale was confirmed. Other workers have found this to be true for stage III. A.E.Kay

14907 THE LONG-TERM STRENGTH OF METALS.

V.I.Likhtman, L.S.Bryukhanova and I.A.Andreeva.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 359-62 (July 11, 1961). In Russian.

Results are given for the relationship between stress and logarithm of time to rupture of zinc crystals of various orientations, polycrystalline zinc and polycrystalline cadmium. Activation energies for the rupture process are obtained and are related to stress for three orientations of the zinc crystals. The specimens had received a surface treatment before testing, the zinc with mercury and the cadmium with gallium, and the results are discussed in terms of the authors' previously published theories of the effect of surface-active agents on the strength of materials. [English translation in: Soviet Physics - Doklady (USA)]. R.F.S.Hearmon

14908 THE TEMPERATURE AND TIME DEPENDENCES OF THE STRENGTH OF HARDENED STEEL.

S.S.Shurakov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 6, 886-95 (Dec., 1960). In Russian.

Reports a study of the effect of the test temperature on the compressive strength of hardened steel from −196° to 40° C and on the dependence of the strength on time under a static load. Cooling reduced the compressive strength and the rate of fall of the strength with time under load. A.Tybulewicz

14909 ORIENTATION DEPENDENT MECHANICAL BREAKDOWN OF A MODEL HIGH POLYMER SOLID.

C.C.Hsiao, J.E.Osborn and D.B.Rozendal.

J. Phys. Soc. Japan, Vol. 16, No. 3, 459-62 (March, 1961).

A theory of mechanical breakdown of a model high polymer solid is given. On the basis of considering a static, a quasistatic, or a dynamic system, the orientation dependent mechanical strength of a linear model polymer solid is analysed. The maximum breaking strength obtainable is six times that of the unoriented strength and is found to occur in the direction of orientation for a fully oriented static system.

14910 THE VARIATION OF MECHANICAL PROPERTIES, STRUCTURE, AND ELECTRICAL CONDUCTIVITY OF SINGLE CRYSTALS UNDER THE INFLUENCE OF A STRONG ADSORPTION-ACTIVE MEDIUM.

E.D.Shchukin, N.V.Pertsov and Yu.V.Goryunov.

Kristallografiya (USSR), Vol. 4, No. 6, 887-97 (Nov.-Dec., 1959). In Russian.

Some relationships in the action of a strong surface-active medium — a thin coating of gallium in the liquid state — on the mechanical and structural properties and the electrical resistance of single crystals of zinc, cadmium, and tin are described. [English translation in: Soviet Physics — Crystallography (USA), Vol. 4, No. 6, 840-50 (June, 1960)]

14911 DEVELOPMENT OF POROSITY IN COPPER DURING CYCLIC HEAT TREATMENT.

I.M.Ry̆bakova and S.Z.Ermol'chik.

Fiz. Metallov i Metallovedenie (USSR), Vol.9, No. 5, 733-40 (May, 1960). In Russian.

Commerical-grade Cu was subjected to 1-300 heat treatment cycles (heating to 650° C at 45° C/min, holding at this temperature for 10 min, water quenching), and the effect of various factors on the formation of pores during this treatment was studied by X-ray diffraction analysis and metallographic examination. The pores were formed at the grain boundaries only, their number and size being proportional to the number of the heating/cooling cycles. The number of pores in a specimen depended on its thickness, and no pores were formed in thin (< 1.5 mm) material. Pores formed in thick material were not uniformly distributed across its thickness, their concentration varying from maximum in the centre of the specimen to zero in the surface layer ~ 1.5 mm thick. With increasing number of the heating/cooling cycles, the pores coalesced, formed micro- and then macro-cracks which ultimately led to fracture of the specimen. The strength of the specimens changed only slightly with increasing number of the heat-treatment cycles, but their ductility decreased rapidly, the reduction in area changing from ~ 90% in untreated specimens to ~ 20% in specimens that had undergone 100 heating/cooling cycles. The development of porosity was attributed to the formation and quenching-in o vacancies during heating and quenching of the metal, respecti The subsequent growth of the pores and the formation of micr cracks were associated with the existence of a stress gradien to the variation of the heating and cooling rates across the thi of the specimen, and with the presence of internal stresses du inhomogeneity of the material. M.H.S

14912 EFFECT OF NON-UNIFORMITY OF THE STATE STRESS IN PROCESSES LEADING TO SLOW FRA

N.D.Sobolev.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 758-67 (May, 1960). In Russian.

An approximate analysis is given of the conditions under one principal crack can develop in metals undergoing process which fracture occurs in a relatively long time (fatigue, cree stress corrosion, etc.). The results are correlated with prev published experimental data, and it is shown how the process fracture is affected by non-uniformity (both initial and that de during the process) of the state of stress. M.H.S

14913 THE QUESTION OF HIGH STRENGTH IN SINGLE CRYSTALS.

R.I.Garber, I.A.Gindin and Yu.V.Shu

Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 918-19 (March, 196 In Russian.

Specimens of beryllium and calcite, suitably orientated t plastic slip and twinning, were tested in compression. The ob strength values were high: 410 kg/mm^2 for Be at 77°K, and 23 mm^2 for calcite at 300°K. At the failing load, the specimens d tegrated instantaneously into a fine powder. [English translat in: Soviet Physics - Solid State (USA), Vol. 3, No. 3, 667-8 (Sept., 1961)]. R.F.S.He

14914 TRAJECTORIES OF BRITTLE RUPTURE CRACK GEODESIC LINES ON THE SURFACE OF A BODY

E.M.Morozov and Ya.B.Fridman.

Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 87-90 (July 1, 1961). In Russian.

The hypothesis that fracture cracks follow geodesic lines developed, allowing for the influence of stress distribution. Application is made to the following examples: a cone subject to torsion; a plane weakened by a circular hole; a half-space subjected to concentrated stress; a sphere. [English translat in: Soviet Physics — Doklady (USA)]. R.F.S.He

14915 X-RAY INVESTIGATION OF CAVITATION EROSI OF METALS.

D.N.Bol'shutkin, V.V.Gavranek and M.Ya.Fuks.

Fiz. Metallov i Metallovedenie, (USSR), Vol. 9, No. 5, 722-5 (May 1960). In Russian.

The mechanism of cavitation erosion was studied by X-ra diffraction analysis of Al single crystals, polycrystalline Cu, a stainless steel specimens, tested in water with the aid of a ma strictive vibrator (7.5 kc/s frequency, 0.065 mm amplitude). dimensions of the blocks of the mozaic structure decreased in first stages of the test (15-20 min), after which they remained constant. The degree of microdeformation ($\Delta d/d$) for the corr ponding period was very small ($\sim 3.4 \times 10^{-4}$), and could not be measured even after prolonged cavitation tests. Comparison c these results with those obtained during studies of the behavio steel, deformed plastically in tension or subjected to dynamic led to the conclusion that the mechanism of fracture of metals cavitation erosion is essentially similar to the mechanism of b fracture due to impact loading. M.H.S

14916 CLEAVAGE FRACTURE IN SINGLE CRYSTALS O SILICON IRON.

R.Honda.

J. Phys. Soc. Japan, Vol. 16, No. 7, 1309-21 (July, 1961).

Sheet specimens of single crystals of 2.9% silicon iron wit {110} surface were extended in the ⟨100⟩, ⟨110⟩ and ⟨111⟩ dire respectively at −196° C, until they fractured. The twins and sl lines were observed in the course of extension as well as after fracture. The following two mechanisms by which slip or twin causes the cleavage were confirmed. In the ⟨100⟩ extension, a which has stopped intersecting with another twin along the ⟨11 direction causes a cleavage on the {100} plane parallel to the i section line. In the ⟨110⟩ extension, two {110} slip systems int secting along the ⟨100⟩ direction cause a cleavage on either of {100} planes parallel to the intersecting line. Cleavage in the ⟨

sion seems to be produced by extended applications of the mechanism.

917 **DISC-SHAPED CLEAVAGE SURFACE FRACTURE OF NaCl CRYSTAL.** T.Fujiwara and S.Nakagawa.
. Hiroshima Univ. A (Japan), Vol. 24, No. 1, 107-15 (July, 1960).

he behaviour of the cleavage surface of NaCl crystals was ed under an electron microscope. Cleavage surfaces were which exhibited disk-shaped fractures in the middle of which were found regularly spaced protuberances. The disk-shaped re surfaces were somewhat raised above the general level of eavage surface. The regularly arranged protuberances about 500 A) appeared mainly on the cleavage step line or on at surface taking the direction 110 or 100, while longish and rotuberances arranged themselves in the direction 100. It was ht that these protuberances were due to impurities contained n the salt crystal. These impurities may have got together the vacancies and, after becoming massed together, become ded tightly in some kind of sessile ring of vacancies when age occurred. Caved-in concavities corresponding to the berances would be expected, and a further investigation is in
A.C.Whiffin

918 **A NOTE ON THE BEHAVIOUR OF FATIGUE CRACKS.** N.E.Frost.
ech. Phys. Solids (GB), Vol. 9, No. 3, 143-51 (July, 1961).

Frost [Proc.Instn mech. Engrs, Vol. 173, 811 (1959)] has ested that, for a given material, the critical alternating stress uired to propagate a crack of length l is given by $\sigma^3 l =$ tant. The significance of such a relationship in interpreting ral well known fatigue phenomena (notch sensitivity, whether ue failure originates at a free surface or at an internal flaw, ffect of environment, etc.) is discussed.

4919 **DYNAMICS OF CRACK PROPAGATION IN GLASS.** S.Bateson.
. Chem. Glasses (GB), Vol. 1, No. 5, 139-42 (Oct., 1960).

An expression for the velocity of crack propagation in a brittle ium is derived on the basis of the distortion energy at the crack ace. Agreement with Mott's equation and with Schardin's experits on vitreous silica and a number of optical glasses is good. ttempt to account for the "mirror" markings on fractured aces achieves partial success by developing the relationship $^{1/2}$ = constant, as is found to be the case experimentally. erically the agreement is poor.

4920 **APPLICATION OF ELECTRICAL METHODS FOR THE DETECTION OF FLAWS AND FOR THE STUDY OF AL STRUCTURE.** I.Vigness.
gress in non-destructive testing, Vol. 2 (see Abstr. 9239 of) p. 61-89.

This review considers resistance changes caused by internal ges within the material, and describes electrical techniques tudy these changes. Flaw detection, fatigue, phase changes in als, anisotropy, magnetostrictive resistivity changes, resist-strain coefficients and the study of lattice defects are ussed. 28 references.
J.B.Birks

4921 **DEFECT ASSESSMENT USING ULTRASONIC WAVES.** D.G.W.Claydon.
gress in non-destructive testing, Vol. 2 (see Abstr. 9239 of 1) p. 165-87.

Describes the techniques of ultrasonic flaw detection using the e-echo test-block comparison method. The test-block design, factors influencing the echo indication, the beam characteristic probe design, and the accuracy and improvement of the method discussed.
J.B.Birks

14922 **FATIGUE PROPERTIES OF ZINC SINGLE CRYSTALS AND POLYCRYSTALS.** M.Yamamoto and J.Watanabe.
hys. Soc. Japan, Vol. 15, No. 11, 2099-100 (Nov., 1960).

Three orientations of single crystals and also polycrystalline cimens of zinc were tested in bending. Polycrystals showed the est fatigue strength and [0001] type single crystals the lowest. fatigue stress endured by all specimens (taken to 10^7 cycles) responds to the minimum stress at which slip or twinning starts the particular orientation in a static test.
H.Mykura

14923 **THE EFFECT OF TEMPERATURE AND DURATION OF LOADING ON THE RELATIONSHIP BETWEEN HARDNESS AND COMPOSITION OF DILUTE SOLID SOLUTIONS.** V.P.Shishokin and A.E.Nikerov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 768-77 (May, 1960). In Russian.

The concentration-dependence of hardness was determined for the alloys: Cd-Hg, Pb-Hg, Pb-Bi, Sn-Hg, Sn-Sb, Cd-Ag, Pb-Cd, Pb-Sn, Pb-Sb, Pb-Na, Bi-Zn, and Cn-Zn; these were subjected to hardness tests conducted under various conditions of the applied load (18.5-61.7 kg), loading time (1-1296 min), and temperature (20-180°C). In the case of alloys with a relatively high (> 20 at.%) solubity of the solute in the solvent metal, the concentration-dependence of hardness for the solid solution range was characterized by a maximum which became more pronounced at higher test temperatures and slower deformation rates. When the hardness tests were made at low temperature and high deformation rates (i.e., short loading times), the maximum on the hardness concentration curves corresponded with the solid solubility limits.
M.H.Sloboda

IRRADIATION HARDENING IN IRON. See Abstr. 12652

14924 **THE HERTZ PROBLEM FOR A RIGID SPHERICAL INDENTER AND A VISCOELASTIC HALF-SPACE.** S.C.Hunter.
J. Mech. Phys. Solids (GB), Vol. 8, No. 4, 219-34 (Nov., 1960).

The penetration of a viscoelastic half-space by a rigid spherical indenter is investigated in a quasi static approximation. Solutions to the problem are obtained for monotonic contact radius and also when the radius possesses a single maximum. The analysis is used to estimate the duration of contact and coefficient of restitution for the Hertzian impact of a spherical indenter on a Maxwell solid.

14925 **ASSESSMENT OF THE STRAIN-RATE SENSITIVITY OF METALS BY INDENTATION WITH CONICAL INDENTERS.** C.D.Davis and S.C.Hunter.
J. Mech. Phys. Solids (GB), Vol. 8, No. 4, 235-54 (Nov., 1960).

An impact indentation test is described for investigating the behaviour of metals and alloys subjected to stress cycles of a few milliseconds duration. The test consists of the normal impact of a conically tipped tungsten carbide indenter on a plane surface of the specimen at impact velocities in the range 2–30 cm/sec. An analysis of impact indentation is made, using a quasi-stationary approach; relations between impression dimensions, contact duration and impact velocity are obtained and verified experimentally. Comparison of the impact test results with those derived from hardness measurements, using the same indenter, affords an assessment of the strain rate sensitivity of the material. Results are reported for a wide range of materials, including copper, aluminium, iron, various steels and non-ferrous alloys.

14926 **ELASTIC RECOVERY OF CONICAL INDENTATIONS.** N.A.Stilwell and D.Tabor.
Proc Phys. Soc. (GB), Vol. 78, Pt. 2, 169-79 (Aug., 1961).

Discusses the changes in shape which occur when a hard conical indenter is pressed into a metal (to form a plastic indentation) and then withdrawn. It is shown that there is little change in the diameter of the indentation during withdrawal but a decrease in its depth. This may be expressed analytically in terms of the elastic constants of the metal and there is reasonable agreement between the theoretical and observed changes in depth. The elastic energy released when the indenter is withdrawn may be calculated and it is shown that this accounts quantitatively for the elastic rebound observed when a conical indenter strikes an elasto-plastic metal. The analysis is also applied to the experimental results given by Davis and Hunter (1959).

14927 **ON THE WEAR OF SAPPHIRE.** R.P.Steijn.
J. appl. Phys. (USA), Vol. 32, No. 10, 1951-8 (Oct., 1961).

The wear resistance of single crystals of sapphire was determined as a function of crystallographic orientation with respect to plane of wear and rubbing direction. Distinct anisotropy was found. Evidence of plastic flow at the wear surface on both basal and prismatic slip systems was obtained. In bulk deformation tests, these systems do not become operative until a temperature of 1000°C is reached for basal slip and 1800°C for prismatic slip. The resistance against wear correlates in a qualitative way with the relative ease of operation of the two slip systems involved. When the orientation is such that both basal and prismatic slip are blocked, a brittle type of wear occurs, characterized by conchoidal fracture. All results confirm that plastic flow during rubbing is a governing factor in, if not an integral part of, the wear process for even such a hard material as sapphire.

14928 THE INFLUENCE OF SPEED ON METALLIC WEAR.

W.Hirst and J.K.Lancaster.

Proc. Roy. Soc. A (GB), Vol. 259, 228-41 (Dec. 6, 1960).

The rate of wear of brass on hardened steel was measured on a pin and ring apparatus over a very wide range of speeds (10^{-2} to 10^{3} cm sec^{-1}). As speed increases the rate of wear first decreases to a minimum and then begins to increase again. Radioactive tracer experiments show that over the whole range of speeds the mechanism of wear remains the same; the wear is of the "severe" type in which metallic debris is produced and a film of transferred brass is built up on the steel surface. The decrease in the rate of wear with speed at low speeds is shown to be due to a reduction in the number and in the size of brass fragments transferred to the steel. At high speeds, the number of fragments transferred continues to decrease and the observed increase in the rate of wear arises solely from an increase in the size of the fragments. This increase is due to softening of the brass by frictional heating and can be prevented by cooling the surfaces. A cross-cylinders friction apparatus was used to determine the cause of the observed variations in the rate of wear with speed. It is found that transfer of brass to the steel occurs when a local region of the brass surface has been deformed a critical number of times. This critical number increases with speed and in consequence the frequency of transfer is less at high speeds. Metallographic sections through brass surfaces show that an extensive pattern of strain develops beneath the surface and the rate of development is again less at high speeds. The fragments of brass which are transferred to the steel are platelets, and their thickness shows that they originate from the region of greatest strain near to the surface. It is suggested that transfer occurs when the brass within this region has been weakened sufficiently by successive deformations. Transfer is not therefore equally probable at each local encounter between surfaces; it depends upon the previous history of the surfaces and is less frequent at high speeds because more encounters are then required to develop the critical state of strain.

14929 HYSTERESIS LOSSES IN ROLLING AND SLIDING FRICTION.

J.A.Greenwood, H.Minshall and D.Tabor.

Proc. Roy. Soc. A (GB), Vol. 259, 480-507 (Jan. 24, 1961).

Previous work on the mechanism of rolling friction has shown that it is mainly due to elastic hysteresis losses in the rolling elements. Under conditions of uniform tension or torsion it is generally assumed that the energy dissipated by hysteresis is a constant fraction (the hysteresis loss factor) of the elastic energy introduced during the cycle. This elastic input energy has been calculated for a hard cylinder or sphere rolling on rubber, and with the above assumption expressions have been obtained for the rolling friction. These expressions predict correctly the dependence of rolling friction on load, ball or cylinder diameter and elastic constants of the rubber. However, the absolute values of the frictional force are too small. The experimental values are two to three times the theoretical estimates. This suggests that it is invalid to use the hysteresis loss factor, as measured in a simple deformation cycle, for more complex cycles such as those involved in rolling. For a thin-walled rubber tube to which tensional and torsional stresses could be applied, the hysteresis energy losses for complex stress cycles were measured. In such a system there are two relevant shear stresses which contribute to hysteresis losses; if these are plotted graphically, a deformation cycle can be expressed by a stress diagram which, in general, will form a closed loop. A hypothesis is put forward which suggests that the losses in the cycle are proportional to the square of the length of this loop. An investigation of different types of stress cycle show that this hypothesis may be used fairly reliably to estimate energy losses in complex stress cycles. In particular it may be shown that if the rubber is deformed in such a way that its elastic strain energy is constant throughout the cycle, marked hysteresis losses occur. The earlier concept would predict no energy loss. This result is of general importance and explains the earlier discrepancies between theoretical and experimental values for the friction of rolling cylinders and spheres. Although this hypothesis has limitations (these and alternative hypotheses are discussed) it is applicable to the deformation of material by a hard roller and an analysis is given for a long cylinder rolling on rubber. It is shown that the losses are over three times as great as those deduced from the earlier concept and for a spherical roller the loss
about twice as great as earlier estimates. This is in good agreement with experiment. The analysis is extended to the case of rolling over short distances and it is shown that the resistance increases linearly from zero as a cylinder, starting from rest, commences to roll. An experimental study indicates that this is approximately true. Only when each element has passed under th
roller and out of the contact region does the hysteresis loss reac
its maximum steady-state value. For minute displacements of a roller, there is evidence that adhesion may not be entirely destr
and though, in general, rolling friction is dominated by hysteresi
losses, it is suggested that under these limiting conditions th
effect of adhesion may not be negligible.

14930 LUBRICATION AT POINT CONTACTS.

J.F.Archard and M.T.Kirk.

Proc. Roy. Soc. A (GB), Vol. 261, 532-50 (May 23, 1961).

Measurements were made of the friction, electrical resistan
and electrical capacity between rotating steel cylinders with the
axes mutually at right angles. The lubricant was a plain hydrocarbon mineral oil. Nominally the surfaces come together at a single point and the apparatus is designed to ensure that this condition is maintained even if the cylinders wear. It is shown that hydrodynamic lubrication exists over a wide range of conditions
loads of a few kilograms it persists even when the speed falls be
1 cm/sec and at higher speeds (~ 100 cm/sec) it is maintained e
when the load becomes large enough to cause bulk plastic flow of hardened steel. Hitherto it has been considered that only bounda
lubrication could occur under these extreme conditions. At very light loads classical hydrodynamic theory applies but as the load
increased a departure from classical theory occurs because the viscosity of the oil increases under the applied pressure. At hea
loads the pressures become large enough to cause appreciable e
tic deformation of the surfaces and a state of elasto-hydrodynam
lubrication is achieved. Under elasto-hydrodynamic conditions t
film thickness can be deduced from the measurements of electri
capacity. A simplified theory of elasto-hydrodynamic lubricatio
point contacts is developed, and the measured values of film thic
ness are in fairly good agreement with those derived from the th
However, the variations of film thickness with viscosity, speed a
radius of curvature forecast by the theory differ significantly fr
those obtained experimentally. The values of the film thickness
range from 2×10^{-6} cm to more than 1×10^{-4} cm. The results, over the whole range, conform to a regular pattern and there is
evidence of any disturbing influence of the surface molecular
even with the thinnest films.

14931 FRICTION OF MOLYBDENUM DISELENIDE.

M.T.Lavik, T.B.Daniel and A.N.Abbott.

J. appl. Phys. (USA), Vol. 32, No. 9, 1795 (Sept., 1961).

14932 LIQUIDLIKE LAYERS ON ICE.

H.H.G.Jellinek.

J. appl. Phys. (USA), Vol. 32, No. 9, 1793 (Sept., 1961).

Shear experiments with ice sandwiched between discs of s
less steel, various polymers, and quartz optical flats, show th
distinct characteristics of sliding to be anticipated from a liqu
layer between ice and surface, whereas tensile tests provide c
cohesive breaks in the ice. The results appear to be only exp
on the assumption of a liquidlike layer not just for the ice : air
interface but also for the ice : metal, ice : polymer, and ice : qu
interfaces. Estimates of layer thickness at −4.5°C range from
10^{-5} to 10^{-6} cm and viscosities from 70 to 700 poises for ice:stai
steel and 15 150 poises for ice : quartz. Shear experiments w
thin water films (0.2 to 1 μ) show similarity with the ice data.
would appear that Kingery's results (Abstr. 19508 of 1960) in c
junction with those on adhesion of ice above, support the liquid
layer theory.

H.H.Ho

14933 FURTHER OBSERVATIONS CONCERNING ELECT EFFECTS DURING CYCLIC STRESSING OF ALKA HALIDE SINGLE CRYSTALS.

G.Remaut, J.Vennik and S.Amelinckx.

J. Phys. Chem. Solids (GB), Vol. 16, No. 1-2, 158-60 (Nov., 19

New experiments are described which support the authors
view that the electrical effects observed during the cyclic stre
of NaCl are due to the periodic motion of charged dislocations.

C.A.Ho

STRUCTURE OF SOLIDS

934 CONCERNING THE THEORY OF SOLID SOLUTIONS
OF ORGANIC SUBSTANCES.
itaigorodskii and R.M.Myasnikova.
allografiya (USSR), Vol. 5, No. 4, 638-42 (July-Aug., 1960).
ssian.
The thermodynamic conditions of solubility, radius of inter-
of an impurity molecule, and the problem of the interblock
ility are considered. Quantitative relations between the
ility and geometric distortions of a lattice are pointed out. A
od for calculation of an impurity molecule interaction radius
en. It is found that, besides the true solubility, an interblock
ility is possible. In the latter case impurity molecules enter
ttice of a solvent only in the boundaries between blocks.
ish translation in: Soviet Physics — Crystallography (USA),
5, No. 4, 610-13 (Jan.-Feb., 1961)].

935 A SECOND ORDER PHASE TRANSITION IN SnSe.
V.V.Zhdanova.
tverdogo Tela (USSR), Vol. 3, No. 5, 1619-20 (May, 1961).
ssian.
Dilatometric measurements of thermal expansion in the three
directions of SnSe show discontinuities at 541°C, indicating
xistence of a second order phase transition at this temperature.
e the transition temperature, two of the expansions are equal,
nSe is then uniaxial. [English translation in: Soviet Physics—
State (USA), Vol. 3, No. 5, 1174-5 (Nov., 1961)].
R.F.S.Hearmon

4936 PHASE-TRANSITIONS IN $Cu[(NH_4)SO_4]_2.6H_2O$.
G.Bhowmik.
n J. Phys., Vol. 34, No. 9, 433-4 (Sept., 1960).
There is a phase change at 67° C in which 4 molecules of water
ost and the structure changes from monoclinic to orthorhombic;
-axis is unaltered. The bearing of this on the loss of magnetic
tropy is discussed.
A.R.Stokes

4937 ON THE POSSIBILITY OF DETECTING SHOCK-
INDUCED SECOND-ORDER PHASE TRANSITIONS IN
IDS. THE EQUATION OF STATE OF INVAR. D.R.Curran.
pl. Phys. (USA), Vol. 32, No. 10, 1811-14 (Oct., 1961).
First-order phase changes in shock-loaded solids have
iously been detected from the formation of multiple-wave
ctures in the solids. It is shown theoretically that a multiple-
k structure under shock loading may also be produced by a
nd-order phase transition. Accordingly, the possibility of
cting shock-induced demagnetization in ferromagnetic metals
alloys is discussed and an experimental attempt to detect such
magnetization in shock-loaded Invar (64 Fe, 36 Ni) is reported.
apolation of data by Patrick suggests a Curie point transition
var in the neighbourhood of 50 kbar. The Hugoniot equation of
e of Invar was obtained over a pressure range of 35 to 160 kbar.
double-shock structure was observed, but a decrease in
pressibility in the neighbourhood of 60 kbar is thought to be
lence of demagnetization.

4938 ON THE EXISTENCE OF A CRITICAL POINT FOR
THE PHASE TRANSITION IN CERIUM.
Beecroft and C.A.Swenson.
hys. Chem. Solids (GB), Vol. 15, No. 3-4, 234-9 (Oct., 1960).
A piston-displacement technique was used to examine the phase
sition in cerium to 20 000 atm and 575° K. The results are
greement with previous thermal data, and show tha the volume
ge decreases with increasing temperature, extrapolating to
somewhere near 60 °K and 20 000 atm. Above roughly 500° K
15 000 atm, however, the transition becomes increasingly
ad out in pressure at constant temperature, and it becomes
e difficult to assign values to the transition pressures, and the
me changes. Although there are definite indications that the
re of the transition is changing at these pressures and tempera-
s, the possibility that the transition is merely becoming
gish cannot be ruled out.

14939 PHASE TRANSFORMATION, TWINNING AND
ANELASTIC PHENOMENON ASSOCIATED WITH
CONIUM DIHYDRIDE. R.Chang.
uclear Materials (Internat.), Vol. 2, No. 4, 335-40 (Dec., 1960).
The atom movements and crystallography of cubic to tetragonal
nsformation in ZrH_2 are studied and discussed according to the phenomenological theories of Bowles and MacKenzie and of Wechsler, Lieberman, and Read. The large internal friction peak found in $ZrH_{1.}$[illegible] (but absent in $ZrH_{1.6}$) suggests that it is associated with a stress-induced twin interface motion. The relaxation phenomenon appears to be controlled by a diffusion process, presumably that of hydrogen, with an activation energy of about 20 000 calories per mole.

14940 EFFECT OF VOLUME PRESSURE ON THE KINETICS OF PHASE TRANSFORMATIONS OF THE FIRST KIND.
A.I.Bȳkhovs'kȳi.
Ukrayin fiz. Zh. (USSR), Vol. 3, No. 4, 488-94 (1958). In Ukrainian.

The author takes into consideration the effect of volume pressure inducing elastic strain on the linear velocity of crystal growth (within the bounds of the two-dimensional nucleus theory) and on the rate of nucleation. Formulae obtained which characterize this effect in the general case and for low pressures. The method of considering only elastic strains quite satisfactorily describes the data of Komar and Ivanov (1936) on the effect of pressure on the linear velocity transformation of white tin into grey. The calculations of the effect of various pressures in the case of a given supercooling and the temperature dependence of ν at a pressure 90 atm are in good agreement with the experimental data. The results obtained furnish grounds for considering the effect of pressure on the general rate of crystallization. The transformation of grey tin into white is discused as an example. The calculated results agree well with the experimental data, which confirms the correctness of the value of the constant describing the transformation $a\text{-Sn} \rightleftharpoons \beta\text{-Sn}$.

LOW-TEMPERATURE TRANSFORMATION IN A MANGANESE FERRITE CRYSTAL. See Abstr. 14381

CRYSTALLOGRAPHY

14941 THE TWO-DIMENSIONAL SHUBNIKOV GROUPS.
A.M.Zamorzaev and A.F.Palistrant.
Kristallografiya (USSR), Vol. 5, No. 4, 517-24 (July-Aug., 1960).
In Russian.

The assignment to points of the plane of the signs + or − in several different senses produces further generalization of the known 17 Fedorov and 80 Shubnikov (Cochran) groups. All the possibilities of nontrivial generalizations are investigated, and the number of essentially new groups is counted up completely. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 497-503 (Jan.-Feb., 1961)].

14942 COMPLETE FINITE SYMMETRY GROUPS OF SCALARS, VECTORS, AND SECOND-RANK TENSORS AND THEIR COMBINATIONS. I.S.Zheludev.
Kristallografiya (USSR), Vol. 5, No. 4, 508-12 (July-Aug., 1960).
In Russian.

The fifteen complete finite symmetry groups of scalars, vectors, second-order tensors and their combinations are considered to exist. (One of the groups is a group of zero tensors). The interpretation of complete finite symmetry groups is given geometrically. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 489-92 (Jan.-Feb., 1961)].

14943 THE COLOUR-SYMMETRY POINT GROUPS (COLOUR CLASSES).
V.L.Indenbom, N.V.Belov and N.N.Neronova.
Kristallografiya (USSR), Vol. 5, No. 4, 497-500 (July-Aug., 1960).
In Russian.

The connection between colour-symmetry point groups and one-dimensional complex representations of ordinary crystallographic groups is investigated for the case of point symmetry. Eighteen colour-symmetry point groups (colour classes) are also deduced without the use of the representation theory. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 477-81 (Jan.-Feb., 1961)].

14944 IRREDUCIBLE REPRESENTATIONS OF THE MAGNETIC GROUPS AND ALLOWANCE FOR MAGNETIC SYMMETRY. V.L.Indenbom.
Kristallografiya (USSR), Vol. 5, No. 4, 513-16 (July-Aug., 1960).
In Russian.

The isomorphism of the 1191 magnetic (Shubnikov's) and 230 common (Fedorov's) group facilitates extremely the solving of problems demanding allowance for the magnetic symmetry of a crystal. One example is the magnetoelectric effect (the linear dependence between the electrical and magnetic fields in some ferro- and antiferromagnetics). The irreducible representations of the magnetic polarization in all magnetic groups are tabulated. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 493-6 (Jan.-Feb., 1961)].

14945 REDUCTION THEORY.

B.N.Delone.

Kristallografiya (USSR), Vol. 5, No. 4, 501-7 (July-Aug., 1960). In Russian.

A proof is first of all given for those reduction conditions that were introduced by Voronoi (1908) without proof. The region V determined by these conditions is a fundamental region. An investigation then follows into the division of the cone K of positive quadratic forms into regions equivalent to V. At the end of the paper, there is a table in which those parts of V which correspond to the different Bravais lattices are indicated. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 482-8 (Jan.-Feb., 1961)].

14946 ULTIMATE MAGNETIC SYMMETRY OF PHYSICAL SYSTEMS.

B.A.Tavger.

Kristallografiya (USSR), Vol. 5, No. 5, 677-80 (Sept.-Oct., 1960). In Russian.

The magnetic symmetry groups containing an axis of infinite order are described. A number of physical systems with the symmetry in question is examined. Some consequences following from the magnetic symmetry of a uniform magnetic field and of a light ray are obtained. [English translation in: Soviet Physics - Crystallography (USA), Vol. 5, No. 5, 646-9 (March-April, 1961)]

14947 POLYMORPHIC PHASE TRANSITIONS AND SYMMETRY.

V.A.Koptsik.

Kristallografiya (USSR), Vol. 5, No. 6, 932-43 (Nov.-Dec., 1960). In Russian.

Curie's symmetry principle is extended to interacting physical objects; a new definition is given for the symmetry of a crystal, and a study is made of the symmetry changes possible in a polymorphic transition; the physical tensor properties of the crystal are used as parameters for the transition. English translation in: Soviet Physics - Crystallography (USA), Vol. 5, No. 6, 889-98 (May-June, 1961)

14948 THE RELATION OF SPOT SIZE TO SIZE AND ANGULAR DISORIENTATION OF CRYSTALLITES.

E.P.Kostyukova.

Kristallografiya (USSR), Vol. 4, No. 6, 826-8 (Nov.-Dec., 1959). In Russian.

The size and disorientation of a crystallite can be found reliably from the size of the interference spot. Rovinskii and Hirsch have given appropriate formulae, but they produce results that differ somewhat. These formulae are examined, and a more general expression is given. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 786-8 (June, 1960)].

14949 AN EXTENDED STUDY OF CRYSTAL FORMS AND THE CRYSTAL MORPHOLOGY OF TWINS.

I.I.Shafranovskii.

Kristallografiya (USSR), Vol. 5, No. 4, 525-9 (July-Aug., 1960). In Russian.

The new concepts of vertex and edge forms contribute to the description of the complex forms of crystals (the skeleton formations, etc.). The simple face forms with re-entrant angles together with the formula of colour symmetry give an exhaustive description of twins. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 504-8 (Jan.-Feb., 1961)].

14950 GROWTH OF TWINNING IN THIN FILM SILVER CRYSTALS.

A.Art and A.Ponslet.

J. Phys. Radium. (France), Vol. 21, Suppl. No. 7, 134A-136A (July, 1960). In French.

Very often, striations appear on electron-microscope pictures of crystals of silver thin layers. According to Ogawa and collaborators (Abstr. 7420 of 1955), these striations are due to twinned crystals in these thin layers. This assumption is confirmed by the present article. It is shown moreover that when there is "epitaxy" of silver on sodium chloride, the striations have a general orientation with respect to the crystallographic axes of the supporting material.

14951 ETCH PATTERNS OF WEDGE-SHAPED ELAST
TWINS.

R.I.Garber and E.I.Stepina.

Kristallografiya (USSR), Vol. 5, No. 5, 811-13 (Sept.-Oct., 1
In Russian.

The etch patterns in the vicinity of scratches made in d
directions and with different loads by means of a steel or c
needle on a polished shear plane of a calcite crystal were st
Both annealed (at 500°C) and unannealed specimens were us
etchant was a weak aqueous solution of CP-4. Wedge-shape
twins, similar to those found on sodium nitrate [R.I.Garber,
eksper. teor. Fiz. (USSR), Vol. 17, 63 (1947)] were observed
stability is due to distortions in the scratch and to changes i
jacent zone of the crystal. When the crystal is annealed the
disappear, leaving a cluster of etch pits. [English translati
Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 773-5
April, 1961)]. S.W

14052 INTERACTION OF TWIN LAMELLAE WITH OBS
LES.

V.M.Kosevich.

Kristallografiya (USSR), Vol. 5, No. 6, 917-23 (Nov.-Dec., 19
In Russian.

Models of the retardation of twin lamellae by macroscop
obstacles are discussed. The additional deformations produc
twin lamellae boundaries in the process of overcoming an ob
are estimated. The critical conditions determining the chara
the interaction of twin lamellae with obstacles are indicated.
[English translation in: Soviet Physics - Crystallography (U
Vol. 5, No. 6, 873-8 (May-June, 1961)].

TWIN BANDS IN THE CRYSTALS OF WHITE TIN.
See Abstr. 14903

NON-BASAL SLIP AND TWIN ACCOMMODATION IN ZI
CRYSTALS. See Abstr. 14904

14953 MICRODOMAIN STRUCTURE IN PARAELECTRI
PHASE OF $NaNO_2$.

S.Tanisaki.

J. Phys. Soc. Japan, Vol. 16, No. 3, 579 (March, 1961).

Oscillation photographs and Laue photographs of $NaNO_2$
the paraelectric phase show two sharp satellites in each side
some of the normal reflections along "a" axis. It is inferred
these satellites that there is a certain periodic structure alo
axis. A suitable model to interpret the satellites is discusse
S

14954 COMPARATIVE OPTICAL AND INTERFERROME
STUDIES ON SYNTHETIC DIAMONDS.

S.Tolansk

Proc. Roy. Soc. A (GB), Vol. 263, 31-8 (Aug. 22, 1961).

Precise optical and interferrometric studies are reporte
the surface characteristics of four different varieties of synth
diamond. The first group shows frequent hopper or skeletal
structure on octahedron faces, with occasional smooth cube fa
Many faces are coated with an irregular thin film. The secon
also shows hopper characteristics on the octahedral faces, ma
slip effects and also very smooth cube planes. Growth spirals
found on some cube faces. Many of the faces are also coated.
third batch there is a complete absence of surface coating, nu
ous plane cube faces are found and the octahedral faces are fr
from hopper effect. The fourth group has characteristics res
the second.

14955 STRUCTURE OF ETCHING FIGURES ON BISMUT
SELENIDE SINGLE CRYSTALS.

B.Kolakowski.

Acta phys. Polon. (Poland), Vol. 20, No. 2, 103-17 (1961).

The formation of etch figures on the (0001) face of bismut
selenide single crystals was investigated. Different etching mi
were found to give rise to figures of different shape and densi
distribution. The mixture best adapted for the detection of dis
tions was that containing bromine and iodine. In order to expl
the different forms and densities of the figures, depending on
procedure of etching, a model is proposed wherein the walls o
etch figures are considered to consist of an assemblage of ste
The model relates the thickness of the steps to the form and o
tion of the figures and to the rate of etching.

14956 SCRIBE-PLATING AND -ETCHING.

W.Rindner and J.M.Lavine.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 869-73 (Sept., 19

A technique is described which permits the fabrication of
ture and microminiature ohmic and doped contacts in complex
configurations on a variety of semiconductor materials. This

iique involves the preferential nucleation of chemiplated and roplated metals on microscopically fine lines scribed on conductor surfaces and the preferential etching of similarly ed lines. Lines of the order of 10^{-4} cm plated with a variety of ls including doping elements. Scribe plating has yielded junctions and offers promise of the fabrication of p—n junction es considerably smaller than those currently available. This iique is also potentially useful in the fabrication of convention- sized devices, some of which are described. Suggestions are nced for the use of this technique in both microminiature and device fabrication.

4957 ETCH FIGURES ON ALUM AND THE DIAMOND PATTERN. M.Omar and T.H.Youssef.

Mag. (GB), Vol. 6, 791-4 (June, 1961).

Potash alum crystals grown from solution had fine octahedron s. They were etched by a quick dip in water. The etch figures ned were not only similar in orientation and appearance to ıral growth" figures on diamond, but were identical with them ery respect. Due attention is paid to "growth" hillocks on one tal and the etch hillocks on the other crystal. Interfacial angles ell as other characterizing marks of both kinds of pits are pared. It is concluded that diamond is not characterized by a ial growth pattern and that in fact all figures naturally obtained iamond are a result of natural dissolution.

4958 DEVELOPMENT OF ETCH PITS IN AS-CAST 99.9945% ALUMINIUM. W.J.Wrazej.

st. Metals (GB), Vol. 88, Pt 5, 239-40 (Jan., 1960).

Etching was carried out first in Keller's reagent for 10 sec and in Lacombe's reagent for a sequence of times with microscopic nination taking place at each stage in the sequence. The etch ffects are ascribed to the existence of local lattice distortion at nterfaces between metal and oxide and at grain boundaries. distortion extends to depths of about 2×10^5 A in the grain.

A.E.Kay

14959 STUDIES ON THE BOUNDARY BETWEEN ETCHED AND GROUND REGIONS OF Ge AND Si SINGLE YSTAL SURFACES BY X-RAY DIFFRACTION TOPOGRAPHY.

shii.

hys. Soc. Japan, Vol. 16, No. 4, 733-6 (April, 1961).

The anomalous boundary effect similar to that found by ushima in quartz (Abstr. 8784 of 1954) were studied by X-ray raction topography methods in Ge and Si single crystals. Both Laue and Bragg cases are examined using Cu Kα and Ag Kα iations for various net planes. Results are reasonably explained assuming a strain gradient perpendicular to the boundary as the vious workers. It was shown that the Borrmann effect as well as ordinary extinction effect are useful in point-by-point examination attice distortions in nearly perfect single crystals.

14960 ETCHING PATTERNS ON (100) PLANES OF THE SINGLE CRYSTAL $K_3Co(CN)_6$. H.Iwasaki.

Radio Res. Lab. (Japan), Vol. 7, 389-403 (July, 1960).

The etching patterns on the surface (100) of a single crystal of $Co(CN)_6$ grown from aqueous solution by the cooling method are ssified into two kinds; one has a "pyramidal" form appearing on $0)^+$ with large density and the other has a "hill-like" form earing on $(100)^-$ with large density. It is inferred that the etch- patterns in the "pyramidal" form are due to the existence of the location line produced in the growing process of a crystal, while "hill-like" patterns are due to the "point defects" containing purities. At present the types and characteristics of dislocation es are made partially clear by means of the "continuous dissolu- n" method. The relation between the crystal structure and the isting manner of dislocation remains to be further considered. photographs are included.

14961 THE ETCH METHOD FOR REVEALING DISLOCATIONS IN ZINC CRYSTALS.

M.Stepanova and A.A.Urusovskaya.

istallografiya (USSR), Vol. 4, No. 6, 913-17 (Nov.-Dec., 1959). Russian.

It is shown that Gilman's etchant is suitable for revealing locations in zinc, while Méléka's etchant is unsuitable for this rpose. Various distributions of dislocations, including ank—Read sources, have been revealed by means of Gilman's hant. English translation in: [Soviet Physics—Crystallography SA), Vol. 4, No. 6, 867-72 (June, 1960)].

14962 THE INFLUENCE OF ELASTIC-RELAXATIONAL STRESSES ON THE CRYSTALLIZATION OF A VERY VISCOUS LIQUID. L.V.Tverskaya.

Dokl. Akad. Nauk SSSR, Vol. 137, No. 5, 1095-7 (April 11, 1961). In Russian.

For Abstract, see Abstr. 11535 of 1961. [English translation in: Soviet Physics — Doklady (USA), Vol. 6, No. 4, 332-4 (Oct., 1961)].

14963 INFLUENCE OF GROWTH CONDITIONS ON SOME PHYSICAL PROPERTIES OF MIXED SINGLE CRYSTALS OF CdS.CdSe. N.I.Vitrikhovskii and I.B.Muzetskaya.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1581-6 (May, 1961). In Russian.

A sublimation method is described for producing single crystals of Cds, CdSe, and mixed CdS.CdSe single crystals of various compositions. The dependence of crystal form on temperature and other crystallization conditions is investigated, and results are reported for spectral distribution of photocurrent, dark conductivity and integral photosensitivity of the crystals. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1148-51 (Nov., 1961)].

R.F.S.Hearmon

14964 HYDRATED OXIDE FILMS ON ALUMINUM. THEIR GROWTH AND THEIR IMPORTANCE IN ELECTROLYTIC CAPACITORS. D.Altenpohl and W.Post.

J. Electrochem. Soc. (USA), Vol. 108, Nol. 7, 628-31 (July, 1961).

The composition and growth of hydrated aluminium oxide films and their dependence on water temperature, reaction time, SiO_2 content, and pH are discussed, with special reference to their influence on etched aluminium foils used on electrolytic capacitors.

14965 "SPIRE" GROWTH ON BISMUTH—MANGANESE ALLOYS IN THE ABSENCE OF A MAGNETIC FIELD.

L.Berenbaum.

J. Inst. Metals (GB), Vol. 88, Pt 6, 280-2 (Feb., 1960).

Tree-like growths called "spires" appear on the surface of compacted mixtures of manganese and bismuth powders after heating at 300° and 365° C. Spires were first observed during low-temperature diffusion studies in the presence of an external magnetic field. The spires reported in this paper were grown in the absence of an external magnetic field, both above and below the Curie temperature of the intermetallic compound MnBi. The mechanism of spire growth is neither an evaporation process nor the expulsion of a phase from the sample during cooling.

14966 THE HYDROTHERMAL CRYSTALLIZATION OF YTTRIUM IRON GARNET AND YTTRIUM GALLIUM GARNET AND A PART OF THE CRYSTALLIZATION DIAGRAM $Y_2O_3—Fe_2O_3—H_2O—Na_2CO_3$.

R.A.Laudise, J.H.Crocket and A.A.Ballman.

J. phys. Chem. (USA), Vol. 65, No. 2, 359-61 (Feb., 1961).

Yttrium iron garnet, $Y_3Fe_2(FeO_4)_3$, and yttrium gallium garnet, $Y_3Ga_2(GaO_4)_3$, were crystallized under hydrothermal conditions. Yttrium gallium garnet was observed to transport in a temperature gradient and crystallized on a seed in 1 M Na_2CO_3 at 1500 atm and 360°, when the starting materials were Ga_2O_3 and Y_2O_3. The system $Fe_2O_3—Y_2O_3—H_2O—Na_2CO_3$ was investigated and yttrium iron garnet was found to form in optimum yields in from one to six days between 685 and 765° at 1330 atm in approximately 3 M Na_2CO_3. Slow decompositions of both garnet and Fe_2O_3 to Fe_3O_4 were observed to decrease the yields at longer times and a mechanism for this effect is proposed. Yttrium iron garnet was found to be congruently saturating and parts of the crystallization diagram were determined. Garnets as large as 2 mm were prepared.

14967 STUDY OF THE CRYSTALLIZATION OF SELENIUM. G.Blet.

J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 17A-26A (Feb., 1961). In French.

When selenium is subjected to thermal treatment, the amorphous (or vitreous) and hexagonal crystal allotropic forms are those which occur most frequently, the first changing into the second when heated a sufficient time. The theory of the dynamics of this transformation is interesting in itself, bit it is also worth while investigating from the practical points of view of the supply of samples for research purposes, and of the technique of making retifiers and photocells. Although some relevant results are available in the literature on the subject, it has been considered preferable to include them in a general theory. The present paper embodies a systematic examination of samples in a metallographic microscope, as well as measurements of their electrical conductivity and of their microhardness. Secondary, but not unimportant, factors, such as the impurity content have also been taken into account.

14968 DIRECT OBSERVATION OF SUBGRAIN-GROWTH OF COLD-WORKED ALUMINIUM BY MEANS OF ELECTRON MICROSCOPY.

H.Fujita.

J. Phys. Soc. Japan, Vol. 16, No. 3, 397-406 (March, 1961).

Transmission electron micrographs of cold-worked Al showed that the crystal grain consists of many subgrains, the smallest size of which is less than 0.1μ. On subsequent heating, the subgrains grew by two kinds of process, i.e. the formation of subgrain-groups and the usual growth, and finally they grew up to a stable polygonal shape of 3-10μ in size. The total area and the structure of sub-boundaries are likely to play a very important role for recrystallization because they act as the sinks of lattice defects in the intermediate course of migration to the recrystallization boundaries, but the recrystallization in situ is not found as a special stage of subgrain-growth. The results obtained in the present work are discussed in relation to a mechanism of the recrystallization which was proposed by the author (1957).

14969 REGROWTH OF GERMANIUM SINGLE CRYSTAL FROM INDIUM MELT.

M.Tomono.

J. Phys. Soc. Japan, Vol. 16, No. 3, 439-53 (March, 1961).

A single crystal of n-type Ge was heated with a small piece of In on it, and subsequently cooled rapidly to cause regrowth of the p-type Ge on the Ge substracted from the indium melt. After removal of the In, the growth pattern on the surface of the regrown Ge was observed. In some cases relatively large growth pyramids were observed, while in others flat patterns with threefold or sixfold symmetry were observed. After the detailed examination, it was concluded that the former represents the growth due to the screw dislocations and its centre is a dislocation array resulting from thermal strain. The shape and size of the growth pyramid vary with the number of screw dislocations which exist at the centre. The latter seems to be caused by surface nucleation.

14970 REGROWTH OF GERMANIUM FROM MOLTEN INDIUM OR LEAD.

M.Tomono.

J. Phys. Soc. Japan, Vol. 16, No. 4, 711-19 (April, 1961).

A single crystal of n-type Ge was alloyed with In on its (111) plane and the resulting regrown layer of p-type Ge was observed. When the specimen was cooled at an intermediate speed, a dendritic crystal was produced on the flank of the pan-shaped regrown layer. In the case of cooling at a very low speed, steps bounded by the (111) plane were also produced on the flank. Any of these may be indicative of the growth due to screw dislocation. On the other hand, when the specimen was cooled rapidly, growth due to surface nucleation took place on the bottom while dendritic growth due to screw dislocation was produced on the flank. As to a specimen made by alloying a Pb—As alloy on a p-type Ge pellet and subsequently cooled at low speed, several layers of striations are observed on its cross-section. By this method, it is possible to make observations on the state in which a misfit grain boundary is formed in the course of regrowth and also on the anomaly of regrowth produced around a blowhole and other foreign materials.

14971 GROWTH AND DISSOLUTION PROCESSES OF G.A.S.H. CRYSTAL.

T.Nakamura, K.Ohi and H.Kubota.

J. Phys. Soc. Japan, Vol. 16, No. 5, 906-12 (May, 1961).

The growing process of a guanidinium aluminium sulphate hexahydrate crystal was observed. If a droplet of saturated G.A.S.H. solution on a slide glass is heated from the upper side, the platelets obtained floating on the drop show six-ray star-shaped terraces. The mechanism of terrace formation is ascribed to bunching of progressing atomic steps. On the other hand, if heated from the lower side, some platelets obtained at the bottom of the droplet are large and thick, which show dislocation etch pits on etching, while some remain small and thin showing no pits on etching. It appears that the growing process is not diffusion-controlled but follows the screw dislocation mechanism. The dissolution process of the G.A.S.H. crystal was observed. Dissolution takes place by progression of macroscopic steps, which are nucleated both at crystal edges and at dislocation emergence points. The kinetics are controlled by diffusion and macroscopic steps are interpreted as bunching of atomic steps.

14972 SPHERULITIC CRYSTALLIZATION OF POLYE

T.Naono.

J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 653-78 (D 1960).

The morphological structure in the course of growth an the rate of growth of branched polyethylene were observed at va temperatures below the melting point. On the basis of the r a new kinetical mechanism of spherulite growth, including th concept of the crystalline cohesive force acting only in a dir perpendicular to the polymer chain, is presented in order to the kinetics of the growth with the morphological structure. change of light transmission through polyethylene film durin isothermal and constant rate cooling crystallization process measured. From the comparison of the results with the gro process of spherulites, the relation between the growth proc spherulite and the change of light transmission was clarified

14973 SPIRAL GROWTH LAYERS ON BARIUM TITANA CRYSTALS. II.

N.V.Gliki and V.A.Timofeeva.

Kristallografiya (USSR) Vol. 4, No. 6, 908-12 (Nov.-Dec., 19
In Russian.

For Pt I, see Abstr. 8263 of 1957. The morphological characteristics of spiral growth layers forming depressions faces of barium titanate crystals are examined, and the featu the internal morphology of these crystals are indicated. The ditions for the formation of transverse steps intersecting the layers are discussed. [English translation in: Soviet Physic Crystallography (USA), Vol. 4, No. 6, 861-6 (June, 1960)].

14974 INFLUENCE OF SUPERSATURATION ON THE STEPPED RELIEF OF A CRYSTAL SURFACE A RATE OF GROWTH.

A.A.Chernov and E.D.Dukova.

Kristallografiya (USSR), Vol. 5,.No. 4, 655-61 (July-Aug., 19
In Russian.

The role of surface energy in the stability and propagati steps during crystal growth is considered theoretically. In th general problem of crystal surface stability during growth, th criterion of stability connected with surface energy is sugges The initial stages of step splitting and the processes of disap ance of a visible spiral, due to the degeneration of macrostep were observed experimentally. The existence of a nonlinear pendence of rate of growth on supersaturation was established case of spiral hillocks. This nonlinearity depends on the Bur vector. [English translation in: Soviet Physics — Crystallogr (USA), Vol. 5, No. 4, 627-33 (Jan.-Feb., 1961)].

14975 GROWTH OF CRYSTALS FROM VAPOUR NEAR TERNARY POINT.

G.G.Lemmlein, E.D.Dukova and A.A.Chernov.

Kristallografiya (USSR), Vol. 5, No. 4, 662-5 (July-Aug., 1960
In Russian.

Nonlinear dependence of rate of growth on crystal temper near the ternary point has been shown experimentally and is d cussed. The assumption is made of the existence of a thin, co densed film on the crystal surface, and some experimental evi is presented in support of this. [English translation in: Sovie Physics — Crystallography (USA), Vol. 5, No. 4, 634-7 (Jan.-F 1961)].

14976 INFLUENCE OF CRYSTALLIZATION CONDITION ON THE DISTRIBUTION OF THALLIUM IN SINGL CRYSTALS OF SODIUM IODIDE.

E.R.Dobrovinskaya and L.G.Éidel'man.

Kristallografiya (USSR), Vol. 5, No. 5, 770-4 (Sept.-Oct., 1960
In Russian.

The distribution of activator impurity in single crystals i course of their growth by the Stockbarger method was studied different conditions of transfer in the liquid phase. [English t lation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 734-7 (March-April, 1961)].

14977 OBSERVATIONS ON THE VARIATION IN FORM O STEPS ON A CRYSTAL SURFACE AS A FUNCTIO SUPERSATURATION.

E.D.Dukova.

Kristallografiya (USSR), Vol. 5, No. 5, 813-15 (Sept.-Oct., 196
In Russian.

The contours of the growth steps on crystals of paratoluid and β-methylnaphthaline held at constant temperature and expo to the corresponding vapour at different supersaturations were observed. The step contours changed progressively from poly ized spirals to smooth spirals through smooth concentric laye

ritic layers with increase in supersaturation. Correlated
ges in mean step height were also observed. [English trans-
n in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5,
8 (March-April, 1961)]. D.G.Holloway

4978 SOME FEATURES OF THE PRECIPITATION OF BARIUM CHROMATE BY AN EXTRA-SLOW HNIQUE.

T.Adamski.
ire (GB), Vol. 190, 524 (May 6, 1961).

A precipitate from dilute barium chloride and potassium
omate showed X-shaped crystals, regular hexagonal plates and
r more complicated forms. Ammonium chromate instead of
ssium chromate brought similar results. Addition of potassium
ride to the solution of potassium chromate produced exclusively
stals of hexagonal type. Addition of barium nitrate and silver
ate to the solution of potassium chromate showed the formation
-shaped crystals of two parts with different shape and colour.
ium sulphate and barium phosphate showed interesting shapes
imilar character. No experimental details are given.

H.E.Schmid

14979 THE LEDGE THEORY OF RECRYSTALLIZATION IN POLYCRYSTALLINE METALS.

.Davies, A.P.Greenough and B.Wilshire.
l. Mag. (GB), Vol. 6, 795-9 (June, 1961).

When a polycrystalline metal specimen is deformed, ledges
st be produced on grain boundaries in the interior of the speci-
, corresponding to slip lines on the external surface, but much
s pronounced. During recrystallization, grain boundary
ration occurs and a ledge would tend to straighten out so as to
uce the total energy by decreasing the area of grain boundary.
e volume swept by the migrating boundary remains stress free,
the height of the ledge is greater than a critical value dependent
he energy density in the deformed material, it is shown that
grain boundary will continue to migrate until the nucleus of a new
in capable of indefinite growth has been produced. The critical
ght h is given by $h = 0.1r = 0.2\gamma/E$ is the energy density of the
ormed material, γ is the grain boundary energy per unit area,
r is the equilibrium radius of curvature of the grain boundary
ween a recrystallized grain and the deformed matrix. On this
is it is shown that when a metal is cold-worked to a given strain,
temperature at which the metal is strained could have an effect
the grain size of the recrystallized specimen.

14980 SOME EXPERIMENTS ON THE GROWTH AND PURITY OF ALKALI HALIDE CRYSTALS AND THEIR RKENABILITY UNDER X-IRRADIATION.

S.K.Datta.
oc. Nat. Inst. Sci. India A, Vol. 27, No. 3, 167-74 (May, 1961).

Attempts were made to prepare single crystals of alkali
lides in as pure a state as possible, and the effect of X-rays on
em were studied. Crystals were grown from aqueous solutions
d the vapour state, and discs prepared by pressing micro-crystals
a die. From the optical absorption versus wavelength curves of
X-irradiated samples of these and of two melt-grown and Ba-
ped water-grown crystals the F-centre concentrations were
lculated. It was observed that impurities caused some increase
the darkenability of the crystals but the effects were not very
rge.

14981 NUCLEATION AND GROWTH OF TWINS IN DISLOCATION-FREE ZINC CRYSTALS.

P.B.Price.
oc. Roy. Soc. A (GB), Vol. 260, 251-62 (Feb. 21, 1961).

Zinc whiskers and platelets with their largest faces in the basal
ane and thin enough $(\lesssim\frac{1}{2}\mu)$ to be transparent to 100 kV electrons
re strained in tension inside the electron microscope and the
cleation and growth of twins observed by the transmission
chnique. These observations were then related to the various
ages of stress—strain curves obtained in a high-sensitivity tensile
achine. All of the crystals were found to be initially completely
ee of dislocations. Twin nucleation occurred in a region where
e applied stress was concentrated, namely at the specimen grips,
a corrosion pit or at a growth step. A critical resolved shear
ress for twinning of ~ 50 kg/mm^2 was found, which is a reasonable
lue for the theoretical twinning stress. Twins propagated at a
te controlled by the strain rate, at a stress of 2 to 20 kg/mm^2 and
the nucleation and movement of twinning dislocations. Usually a
ngle twin was formed and grew until it transformed the entire
ystal. Basal glide often occurred in a twinned region, and fracture
ok place in the twin by the propagation of a crack along a basal
ane on which a large amount of glide had occurred. The transformation of a matrix containing dislocations with various possible Burgers vectors is considered and the differences between twinning in bulk crystals and in whiskers and plates are discussed.

14982 THE RELATIONSHIP BETWEEN THE DISSOLUTION SHAPE AND SOLUTION ANISOTROPY IN CUBIC CRYSTALS.

M.Yamamoto.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 13, No. 3, 151-9 (June, 1961).

It is shown, from experiment as well as from phenomenological considerations, that the final or limiting shape of an initially spherical crystal dissolved slowly is generally a polyhedron bounded by planar faces extended along neighbouring principal crystal directions. The anisotropy of solution rate can be determined as the condition for a given polyhedron to be the final dissolution shape of an initially spherical crystal. The relationship between the final dissolution shape of an initially spherical crystal and its solution anisotropy is considered for the case of a cubic crystal and it is shown that the relationship derived here accords well with Ellis' and Batterman's observations (Abstr. 1346 of 1955; 2059 of 1958) on the dissolution shapes produced by No. 2 etch from initially spherical germanium crystals. See also two following abstracts.

14983 THE RELATIONSHIP BETWEEN THE GROWTH SHAPE AND GROWTH ANISOTROPY IN CUBIC CRYSTALS.

M.Yamamoto.
Sci. Rep. Res. Insts Tohoku Univ A (Japan), Vol. 13, No. 3, 160-7 (June, 1961).

Using the fact that the shape of slowly grown crystal is generally a polyhedron surrounded by close-packed faces, the anisotropy of growth rate can be determined as the condition for a given polyhedron to be the final shape of an initially spherical crystal (or of an initially arbitrarily shaped crystal in the case of long-term growth). The relationship between the growth shape and growth anisotropy is considered for the case of cubic crystals, taking, for simplicity, only the growth shapes surrounded by one, two, or all of $\{100\}$, $\{110\}$ and $\{111\}$ planes alone. It is shown that the relationship derived here accords well with Spangenberg's observations (1924, 1925) on the growth shapes of potassium alum crystals and of NaCl crystals containing urea. See also following and preceding abstracts.

14984 ON THE GROWTH AND DISSOLUTION SHAPES OF SPHERICAL SHELL CRYSTALS AND THE SHAPES OF ETCH PITS ON CRYSTALS.

M.Yamamoto.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 13, No. 3, 168-73 (June, 1961).

Previous considerations (see two preceding abstracts) of the relationships between the growth shape and anisotropy of growth rates and between the dissolution shape and anisotropy of solution rates, respectively, in slowly dissolved and in slowly grown crystals, show that the final or limiting shape in slow inward dissolution (e.g. the slow dissolution of a spherical crystal) and in slow inward growth (e.g. the slow growth of the inner surface of a spherical shell crystal) is a polyhedron surrounded by planar faces subtended among neighbouring principal crystallographic directions, while that in slow outward growth (e.g. the slow growth of a spherical crystal) and in slow outward dissolution (e.g. the slow dissolution of the inner surface of a spherical shell crystal and the formation of etch pits) is a polyhedron surrounded by planar faces normal to principal directions. These conclusions are found to accord well with observations.

THE PREPARATION OF SOME II-V SEMICONDUCTING COMPOUNDS. See Abstr. 14462

14985 DETERMINATION OF THE ACTIVATION ENERGY OF RECRYSTALLIZATION OF Cr.

O.K.Butÿlenko, I.H.Kurdyumova and V.I.Trefilov.
Ukrayin.fiz. Zh. (USSR), Vol. 4, No. 6, 813-14 (1959). In Ukrainian.

14986 IMPERFECTIONS IN YTTRIUM IRON GARNET CRYSTALS.

D.C.Doughty and E.A.D.White.
Acta cryst. (Internat.), Vol. 13, Pt 10, 761-2 (Oct., 1960).

Yttrium iron garnet crystals grown by the fluxed-melt technique from lead oxide often contain inclusions of lead-rich phases. In large crystals these inclusions are oriented and regular. Photographs of crystal sections show them to be associated with an initial dendritic stage of growth. Limitations of the growth technique are discussed.

14987 GROWING LARGE MONOCRYSTALS OF LEAD.
M.D.Živanović, J.M.Konstantinović and D.M.Jović.

Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 10, 43-6 (March, 1960).

In order to avoid difficulties encountered in cutting monocrystals of lead to obtain determined crystallographic planes, crystal seeds and a special crucible were used to grow monocrystals with required orientation (dimensions 16 × 6 × 0.8 cm).

14988 ON THE PREPARATION OF BaTiO$_3$, SINGLE CRYSTALS BY AN EVAPORATION METHOD.
H.T.Arend.

Czech. J. Phys., Vol. 10, No. 12, 971 (1960).

A method of growing single crystals of BaTiO$_3$ by evaporation of a solution of BaCO$_3$, TiO$_2$ and BaCl$_2$ is reported. The method may enable the defect structure to be controlled by varying the partial pressure of the oxygen in the atmosphere. J.Holt

14989 PREPARATION OF SINGLE-CRYSTAL BORON.
C.P.Talley.

J. appl. Phys. (USA), Vol. 32, No. 9, 1787-8 (Sept., 1961).

Some technical details are given relating to the growth of single crystals of β-rhombohedral B, approximately 1.5 cm diameter and 1 cm long, using the method of floating zone-melting with electron bombardment heating under vacuum. The rods from which the crystals were grown were prepared by chemical vapour plating on to 25 μ diameter W filaments. An X-ray shadowgraph (illustrated) of a partially zone-melted B rod shows that the original W core dissolves in the B and concentrates with other impurities in the advancing molten zone. S.Weintroub

14990 APPLICATION OF THE CZOCHRALSKI METHOD TO DIVALENT METAL FLUORIDES.
K.Nassau.

J. appl. Phys. (USA), Vol. 32, No. 10, 1820-1 (Oct., 1961).

The Czochralski method of pulling from the melt was applied to the growth of single crystals of divalent fluorides of Ca, Sr, Ba, Co, and Mn, and the compound KMnF$_3$. The trivalent rare earth ions Ce, Nd, Sm, Eu, Gd, Tb, and Yb were introduced into CaF$_2$ and the distribution coefficient was determined to be close to unity in all cases.

14991 GROWTH OF ZnSb SINGLE CRYSTALS.
R.L.Eisner, R.Mazelsky and W.A.Tiller.

J. appl. Phys. (USA), Vol. 32, No. 10, 1833-4 (Oct., 1961).

A zone technique which should be applicable to many peritectic type compounds was used to grow good-quality single crystals of ZnSb. It consists here of moving a molten antimony-rich zone along a charge of stoichiometric composition headed by some crystalline ZnSb.

14992 THE USE OF THERMOELECTRIC EFFECTS DURING CRYSTAL GROWTH.
J.R.O'Connor.

J. Electrochem. Soc. (USA), Vol. 108, No. 7, 713-15 (July, 1961).

By passing an electric current through the solid-liquid interface during the growth by the Czochralski technique, the Peltier cooling can be utilised to increase the steady-state rate of crystallization. An analysis of the practical situation is compared with experiments on the growth of Ge crystals and is found to give fairly good quantitative agreement. C.A.Hogarth

14993 THE GROWTH OF BARIUM TITANATE SINGLE CRYSTALS FROM MOLTEN BARIUM FLUORIDE.
R.C.Linares.

J. phys. Chem. (USA), Vol. 64, No. 7, 941-2 (July, 1960).

Reports the solubility of BaTiO$_3$ in BaF$_2$ as 16.5 mole % at the eutectic point of 1260°C to 49.2 mole % at 1393°C. BaTiO$_3$ crystals (butterfly twins and cubes) were grown in slowly cooled melts and large single crystals were grown on rotating seeds which were lowered into the surface of a cooling melt. D.G.Holloway

14994 CRYSTAL-PULLING FURNACE FOR GALLIUM ARSENIDE.
R.Wickham.

J. sci. Instrum. (GB), Vol. 38, No. 10, 396-9 (Oct., 1961).

The design and operation of the equipment are described. Features of the design include a demountable quartz system with rapidity of set-up and ease of operation, close control of the arsenic pressure in the tube, and very good vision during the crystal growing cycle. The heating element is of resistance-heated graphite and is traversable.

14995 CONTROLLED CRYSTALLIZATION OF MELTS CONTAINING IMPURITIES. II.
I.O.Kulik and G.E.Zil'berman.

Kristallografiya (USSR), Vol. 4, No. 6, 898-903 (Nov.-Dec.,
In Russian.

For Pt I, see Abstr. 13955 of 1960. A derivation is give
the temperature distribution in a crystal grown from the mel
This distribution and the earlier results are used to calculat
concentration changes resulting from thermal diffusion. The
radial distribution of the impurity is examined in relation to
caused by curvature of the crystallization surfaces. [English
translation in: Soviet Physics—Crystallography (USA), Vol.
No. 6, 851-6 (June, 1960)].

14996 HYDROTHERMAL SYNTHESIS OF CORUNDUM W IMPURITIES.
R.P.Bashuk, V.P.Basaev, R.B.Tsadkina and S.A.Faivusovich.

Kristallografiya (USSR), Vol. 5, No. 4, 666-7 (July-Aug., 1960
In Russian.

The Verneuil method of growing synthetic corundum crys
allows chromium ions to be introduced into the lattice in suffi
quantity to give paramagnetic properties, but not sufficient an
of iron or titanium. Hydrothermal synthesis was used, and F
ions incorporated at a concentration one or two orders higher
by the Verneuil synthesis. [English translation in: Soviet Ph
Crystallography (USA), Vol. 5, No. 4, 638-9 (Jan.-Feb., 1961)
R.V.

14997 PRODUCTION OF TOURMALINE UNDER HYDRO THERMAL CONDITIONS.
E.N.Emel'yanova and T.A.Zigareva.

Kristallografiya (USSR), Vol. 5, No. 6, 955-7 (Nov.-Dec., 196
In Russian.

A note on the conditions under which a tourmaline seed w
grow in the range 350°-600°C at 400-3000 atm. [English trans
in: Soviet Physics—Crystallography (USA), Vol. 5, No. 6, 910
(May-June, 1961)]. D.G.H

14998 CRYSTAL GROWTH OF GALLIUM ARSENIDE USI CARBON BOATS.
J.R.Knight.

Nature (GB), Vol. 190, 1001 (June 10, 1961).

GaAs ingots grown in silicon boats show wetting and poly-
crystallinity, whereas carbon and carburized silica boats appe
facilitate the growth of single crystals although the latter are
strongly n-type and the observed mobility indicates compensa
The absence of wetting and chemical analysis suggest that the
increase in donor concentration is not due to C while spectros
examination confirms the presence of Si in "fair amounts". T
mechanism of formation of free silicon is discussed and the ra
enters the melt appears to be limited mainly by gaseous diffus
and convection. It is concluded that carbon should be a suitab
crucible material for GaAs in the absence of reducible oxides
as silica. G.C.W

14999 A NEW TECHNIQUE FOR THE PRODUCTION OF SYNTHETIC CORUNDUM.
E.A.D.White.

Nature (GB), Vol. 191, 901-2 (Aug. 26, 1961).

Good-quality crystals of corundum, pure and doped with t
ition metal oxides, were produced from solution in lead fluori
The process was carried out in a platinum crucible heated in
conventional laboratory furnace. The crystals were produced
spontaneous nucleation on slow cooling as hexagonal plates up
2-3 cm across. The thickness of the plates is largely depende
on the initial conditions of cooling, and in favourable circumst
they measure up to 1 cm along the c-axis. The incorporation
high concentrations of paramagnetic ions can be readily achie
this technique, and the products have the additional advantage
being strain-free. H.E.S

15000 DERIVATION OF SOME EQUATIONS IN THE THE OF ZONE REFINING.
B.A.Volchok.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1232-7 (April, 1961).
In Russian.

Mathematical theory of zone refining of an arbitrary subs
Equations are derived for the concentration of impurity after
passes. [English translation in: Soviet Physics—Solid State (
Vol. 3, No. 4, 894-8 (Oct., 1961)]. A.F.

5001 THE PURIFICATION OF KCl BY THE ZONE REFINING METHOD. M.Inoue and H.Mizuno.

ıys. Soc. Japan, Vol. 16, No. 1, 128 (Jan., 1961).

The dependence of zone speed and repeated refining on purifica- is discussed. Fair agreement with theoretical calculations is hed. H.E.Schmid

5002 THE THEORY OF ZONE DRAWING OF SEMICONDUCTORS IN THE PRESENCE OF A GAS PHASE.

adelung.

hys. (Germany), Vol. 162, No. 5, 508-15 (1961). In German.

In zone refining of InAs and InP it was found that the removal ome elements (especially S and Se) was very difficult. Due to ease with which these elements evaporate, it may be conject- that the reason for this behaviour is not only the fact that the centration ratio (gas to condensed phase) is near unity, but also impurities evaporated during one drawing are incorporated n at a later drawing. In order to check this and to devise hods for avoiding this effect an analysis is given of the theory of drawing and of oriented solidification when the gas phase is sent. F.Ansbacher

15003 FORMATION AND ORIENTATION OF TUNGSTEN WHISKERS. H.Ahlborn and G.Wassermann.

a. metallurgica (Internat.), Vol. 8, No. 12, 897-8 (Dec., 1960). erman.

Whiskers were grown on tungsten by heating above 2800° C in ist hydrogen. Lengths of up to one millimetre were obtained with knesses of the order of one micron. The long axes of the whiskers e of high index and, in general, were within ±4° of the axis of the e crystal in the wire. J.Holt

15004 DENDRITIC AND SPHEROIDAL GROWTH. G.Horvay and J.W.Cahn.

a metallurgica (Internat.), Vol. 9, No. 7, 695-705 (July, 1961).

Exact solutions to the diffusion equation are obtained which respond to diffusion controlled growth of elliptical paraboloids ndrites; forward growth with linear time dependence) and spheroids owth with square root of time dependence). The elliptical den- te includes as special cases the dendrite of circular cross-section the dendrite platelet. The dependence of the velocity V of dritic growth on (the smaller) tip radius of curvature R, under- ling $\Delta\theta$ and axis ratio $1/\sqrt{(1 + B)}$ of the elliptic cross-section ound to be of the form $V \propto (\Delta\theta)^n/R$, where the exponent n, a wly varying function of $\Delta\theta$, is (contrarily to past assumptions) iceably greater than 1 in the range of experimentally accessible lercoolings. The value of n is about 1.2 for the circular cross- tion ($B = 0$), and about 2 for the dendritic platelet ($B = \infty$). The eroid solution includes as special cases the known results for sphere, the circular cylinder and the plate.

15005 HYPOTHESIS ON THE IONIC MECHANISM OF THE GROWTH OF WHISKERS OBTAINED BY REDUCTION THE METAL HALIDES. J.Mazur and J.Rafałowicz.

it. J. appl. Phys., Vol. 12, No. 10, 569-71 (Oct., 1961).

On the basis of experimental results the authors put forward hypothesis of the existence of an ionic mechanism of whisker owth side by side with a non-ionic (atomic or molecular) chanism. The ionic concentration calculated from the current nsity is of the order of 10^{12} ions/cm^3 at 650° C and therefore the ssibility of an ionic mechanism of whisker growth cannot be cluded: this conclusion is reinforced by the observed velocity of owth of copper whiskers, and the influence exerted on this growth an electric field. These preliminary measurements and qualitat- observations make the simultaneous coexistence of the two growth chanisms an acceptable hypothesis.

15006 OBSERVATIONS ON THE GROWTH OF α-IRON SINGLE CRYSTALS BY HALOGEN REDUCTION.

M.Wayman.

appl. Phys. (USA), Vol. 32, No. 10, 1844-5 (Oct., 1961).

By large scale modification of established whisker growing chniques, single crystals of α-iron could be produced between nd 2 mm in diameter and up to 80 mm in length. These crystals ew along a (100) axis and had {100} faces, and their final size peared to depend upon the quantity of $FeCl_2$ vapour available for duction. Some growth features are reported.

15007 GERMANIUM DENDRITE STUDIES. I. STUDIES OF TWIN STRUCTURES AND THE SEEDING MECHANISM. J.W.Faust, Jr and H.F.John.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 855-60 (Sept., 1961).

The importance of suitable seeds in dendritic growth of long ribbons of semiconductors is discussed, and investigations to determine the characteristics of suitable seeds are reported. Studies of growth buttons yielded information about the initiation of spontaneous and also controlled dendritic growth from buttons. Some information on the growth of the dendrites is presented to suggest that the growth mechanism is more complicated than previously presumed.

15008 GERMANIUM DENDRITE STUDIES. II. LATERAL GROWTH PROCESSES. J.W.Faust, Jr and H.F.John.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 860-3 (Sept., 1961).

Growth processes in germanium dendritic ribbons were studied by metallographic techniques. It is shown that the formation of a ribbon is a complex process involving the lateral extension of arms from the central core to give, at one stage, an H-shaped cross-section. Segregation effects between the H-arms can be used to produce p—n junction configurations. Some comparisons are made between dendrites of highly doped and normally doped Ge. The factors which affect the continuity of the twin structure are also discussed.

15009 GERMANIUM DENDRITE STUDIES. III. DISLOCATIONS. J.W.Faust, Jr and H.F.John.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 864-8 (Sept., 1961).

The dislocation arrays in germanium dendritic ribbons are described. It is shown that there are three main areas where dislocations can occur. The sources of these dislocations were found to be entrapped molten germanium which on freezing causes plastic deformation. The arms of the central star patterns were found to consist of dislocation half-loops.

15010 THE GROWTH AND CERTAIN PROPERTIES OF METAL WHISKERS. D.Yu.Ovsiyenko.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 5, 545-63 (1959). In Ukrainian.

A brief review of given of papers dealing with the growth and properties of metal whiskers. Examples and methods are presented of growing whiskers by uniting various (sulphate, halide and other) metal compounds, by electrical precipitalion, by condensation of the gaseous state, etc. A brief discussion is given on the current notions as to the mechanism of whisker growth. The results are presented of studies of the properties of whiskers. It is shown that the strength of metal whiskers is many times greater than that of large crystal and proves to be close in a number of cases to the theoretical strength calculated for perfect crystals. Several examples are also cited, illustrating the distinctive features of whiskers with regard to their conductivity and phase transformations. Certain conclusions are drawn as to the theoretical and practical importance of investigations of the growth and properties of whiskers. Bibliography of 93 items.

15011 EPITAXY AND TWINNING IN FOILS OF SOME NOBLE METALS CONDENSED UPON LITHIUM FLUORIDE AND MICA. M.J.Hall and M.W.Thompson.

Brit. J. appl. Phys., Vol. 12, No. 9, 495-8 (Sept., 1961).

Foils up to 2.5×10^{-3} cm in thickness, of Cu, Ag, Pd and Au, were evaporated onto LiF and mica crystals. Epitaxial growth was observed within fixed temperature ranges for each substrate—metal combination. X-ray diffraction of the foils produced sharp patterns of spots which indicated a principal orientation of crystallites in direct alignment with the substrate crystal, together with twins whose presence was confirmed by metallography. The observations are discussed in terms of a nucleation and growth model.

15012 EPITAXY OF CRYSTALS OF NICKEL AND OF IRON OBTAINED BY REDUCTION IN THE GASEOUS PHASE OF NICKEL CHLORIDE AND OF IRON PERCHLORIDE AND THEIR DEPOSITION ON CLEAVAGES OF ALKALI HALIDE AND MUSCOVITE CRYSTALS. L.Capella.

C.R. Acad. Sci. (France), Vol. 252, No. 22, 3465-6 (May 29, 1961). In French.

Data are given on the orientations of the deposited layers and the temperatures above which epitaxy occurs. A.R.Stokes

15013 EPITAXIAL SILICON FILMS BY THE HYDROGEN REDUCTION OF $SiCl_4$. H.C.Theuerer.

J. Electrochem. Soc. (USA), Vol. 108, No. 7, 649-53 (July, 1961).

Epitaxial films of silicon with controlled thickness and resistivity either n- or p-type may be grown using the hydrogen reduction of $SiCl_4$ appropriately doped with PCl_3 or BBr_3. The basic chemistry and reaction kinetics pertinent to the growth of these films are discussed in detail in this paper.

15014 SINGLE CRYSTAL SILICON OVERGROWTHS.

A.Mark.

J. Electrochem. Soc. (USA), Vol. 108, No. 9, 880-5 (Sept., 1961).

The pyrolytic process for the vapour phase deposition of single-crystal silicon overgrowths on parent substrates is described. This method utilizes the dissociation of silicon tetrachloride by hydrogen in an open tube flow process. Free energy and vapour pressure data are plotted for $SiCl_4$, BCl_3, and PCl_3 showing the dissociation relationship between these reacting species for junction formation. Photographs indicate the dependence on temperature of the silicon morphologies that deposit on the substrates, other variables being held constant. Because of the low thermal conductivity of silicon, emphasis is placed on direct contact heating of the silicon substrates to control overgrowth quality. Large temperature gradients were found to exist on the substrate surface with indirect heating by the reactant gases.

15015 EPITAXIAL GROWTH OF CRYSTALS ON ONE-DEGREE ORIENTED SUBSTRATES. A.Goswami.

Nature (GB), Vol. 191, 160-1 (July 8, 1961).

Electron-diffraction observations are described which show the orientation of NiO layers on Ni substrate and of Co_3O_4 and CoO layers on Co substrates. A.R.Stokes

15016 PREPARATION OF MONOCRYSTALLINE CUPROUS OXIDE. Y.Ebisuzaki.

J. appl. Phys. (USA), Vol. 32, No. 10, 2027-8 (Oct., 1961).

A method is described for preparing large single crystals of cuprous oxide by oxidation of monocrystalline copper. The initial oxidation is performed slowly at low oxygen pressure and temperature, to promote oriented growth of the oxide film. The cuprous oxide crystals obtained from the oxidation process showed subgrain boundaries which were removed by subsequent annealing.

15017 CRYSTAL CHEMISTRY OF COMPLEX COMPOUNDS OF GROUP EIGHT METALS.

G.B.Bokii and M.A.Porai-Koshits.

Kristallografiya (USSR), Vol. 5, No. 4, 605-19 (July-Aug., 1960).

In Russian.

Deals with the stereochemical peculiarities and regularities in the structure of these complex compounds. Octahedral coordination is typical of almost all Gp VIII metals, regardless of their magnetic and valence state, with the exception of: (1) diamagnetic compounds of divalent Ni, Pd and Pt with planar configuration of the complexes (sometimes with a distorted octahedral configuration); (2) high-spin compounds of divalent Co and some Ru and Os compounds with tetrahedral complexes (having multiple bonds in the inner sphere); (3) carbonyl compounds, compounds with a sandwich structure and other compounds with vaguely expressed valence of the central atom. Structural types of compounds containing octahedral complexes are determined by the metric relations between complex and ions of the outer sphere. MeA_2X_2 compounds form a special group of related chain structures. Comparison of the structures of divalent Fe, Co, Ni, Cu and Ni, Pd, Pt discloses regularities in the change of magnetic state and coordination, both in the addenda series CN, NO_2, NCS, Br, Cl, O, F, and replacement of acid radicals by neutral addenda. The investigation of structures with plane complexes afforded the possibility of estimating trans-influence, established the existence of three-centre bonds and revealed the group of related dimeric compounds of $AXMeY_2MeXA$ composition. A study of Os and Ru compounds with multiple bonds has disclosed a regular alternation of the Me—O distances (in the series OH_2, OH, O) and Me—N distances (in the series NH_3NO and N) and a decrease in the Os—X distances along the coordinate O = Os—X (where X = Cl, Br or H_2O). Bibliography of 91 items. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 580-93 (Jan.-Feb., 1961)].

15018 CRYSTAL CHEMICAL STUDIES OF SUBSTANCES PEROVSKITE-TYPE STRUCTURE AND SPECIAL ELECTRIC PROPERTIES.

Yu.N.Venevtsev, G.S.Zhdanov, S.N.Solov'ev, E.V.Bezus, V.V.I
S.A.Fedulov and A.G.Kapyshev.

Kristallografiya (USSR), Vol. 5, No. 4, 620-6 (July-Aug., 1960)

In Russian.

Anomalous changes were found in the lattice parameters
dielectric and piezoelectric properties of (Ba,Pb)TiO_3 solid so
Some of these anomalies are due to the different ions respons
for the ferroelectric activity of $BaTiO_3$ and $PbTiO_3$ (B ion = T
A ion = Pb). Some of the discrepancies between X-ray and opt
data on the symmetry of the high-temperature phases of NaNb
were removed by the use of X-ray method. The $BaTiO_3$-type
solutions obtained as the result of simultaneous substitution o
and Ti ions by A' and B' ions respectively (where A' = Ca, Sr,
B' = Sn, Zr, Al, Cr) were studied. The data obtained, together
known data on solid solutions, in which Ba and Ti ions are rep
by A' = Ba, Sr, Ca and B' = Ti, Sn, Zr ions, permits the analy
the influence of different factors on the Curie temperature. It
shown that the dielectric properties of some ferro- and antife
electric materials can be substantially improved by varying th
composition. A general method for calculating the internal fie
developed for the crystal structures of any possible dipole co
rations. The method is applied to the real orthorhombic struc
of $CaTiO_3$. In this case, the internal electric field at the Ti si
equal to zero in contrast to the case of ABO_3-type ferroelectri
materials. [English translation in Soviet Physics—Crystallog
(USA), Vol. 5, No. 4, 594-9 (Jan.-Feb., 1961)].

RELATIONSHIP BETWEEN CRYSTAL SYMMETRY AND
MAGNETIC PROPERTIES OF IONIC COMPOUNDS CONTAININ
Mn^{3+}. See Abstr. 14670

15019 APPARATUS FOR THE ELECTROCHEMICAL CUTTING OF METAL SINGLE CRYSTALS.

P.Spinedi and M.Crudeli.

Ricerca sci. (Italy), Vol. 30, No. 7, 1045-50 (July, 1960).

In Italian.

An arrangement for the electrochemical polishing and etchi
of mono- and polycrystalline metal specimens for metallograp
purposes is described. To cut a specimen a suitable electroly
is sprayed on the specimen which is anodically polarized. The
nozzle from which the electrolyte flows in a thin jet forms the
cathode. The advantages of the method are discussed and exa
of results obtained with the apparatus are illustrated.

S.Wei

CRYSTAL LATTICE STRUCTURE

15020 SUMMARIZED PROCEEDINGS OF A CONFERENC X-RAY ANALYSIS — GLASGOW, APRIL 1961.

J.C.Speakman.

Brit. J. appl. Phys., Vol. 12, No. 9, 429-32 (Sept., 1961).

The Spring Conference of the X-ray Analysis Group of the
Institute of Physics and the Physical Society was held in the
Chemistry Department of Glasgow University, on 6th and 7th A
1961. The subject of the Conference was "The Structures of
Organic Compounds", but this phrase has been interpreted broa
and the seventeen papers presented covered a range of topics,
always closely related. This summarizing report therefore co
the proceedings in an arrangement suggested by subject matter
rather than dealing with each paper and its subsequent discussi
in chronological order.

15021 BIBLIOGRAPHY ON MOLECULAR AND CRYSTAL STRUCTURE MODELS. D.K.Smith.

Nat. Bur. Stand. (USA), Monogr. No. 14, 7 pp. (1960).

The references are classified into those discussing model
general, static models, dynamic models, or construction devic
The static models are further classified into molecular (Fishe
Hirschfelder—Taylor type), closed packing, open molecular, op
crystal structure, open with parallel rods, polyhedral and misc
eous models. A short annotation is given which describes the
types and indicates the more significant articles pertaining to

5022 PROPOSAL FOR THE INTERPRETATION OF THE GENERALIZED BRAVAIS—FRIEDEL LAW (LAW OF NAY AND HARKER). P.Hartman.

.Acad. Sci. (France), Vol. 252, No. 21, 3288-9 (May 14, 1961).
rench.

Discusses the relation between the structural symmetry and morphological symmetry in terms of interatomic translations "anti-translations" (e.g. distance from Na^+ to Cl^- in NaCl cture). See Abstr. 7860 of 1961. A.R.Stokes

15023 SPACE GROUP OF WHITE TIN. I. SYMMETRY POINTS. M.Miasek and M.Suffczyński.

l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), . 9, No. 6, 477-82 (1961).

Using the body-centred model of white tin, the characters of representations of the space groups for the points of high mmetry in the Brillouin zone are worked out and tabulated. R.F.S.Hearmon

15024 SPACE GROUP OF WHITE TIN. II. SYMMETRY LINES AND PLANES. M.Miasek and M.Suffczyński.

l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), . 9, No. 6, 483-7 (1961).

See preceding abstract. The irreducible representations of single and double groups for the lines and planes of high nmetry are tabulated. R.F.S.Hearmon

15025 SPACE GROUP OF WHITE TIN. III. DOUBLE GROUP. M.Suffczyński.

ll. Acad. Polon. Sci. Ser. Sci. math. astron.phys. (Poland), l. 9, No. 6, 489-95 (1961).

See two preceding abstracts. The irreducible representations the double group at the points of high symmetry are tabulated. R.F.S.Hearmon

15026 THE BASIC THEOREM OF THE CLOSE-PACKED SPHERICAL STRUCTURE. N.V.Belov.

istallografiya (USSR), Vol. 4, No. 6, 918-19 (Nov.-Dec., 1959).
Russian.

[English translation in: Soviet Physics—Crystallography (USA), l. 4, No. 6, 873-4 (June, 1960)].

15027 CONCERNING DISORDERED STRUCTURES AND ORDERING PROCESSES. Z.G.Pinsker.

istallografiya (USSR), Vol. 5, No. 4, 627-37 (July-Aug., 1960).
Russian.

Reports an attempt to classify disordered structures and to cuss some general questions that are connected with ordering cesses. [English translation in: Soviet Physics—Crystallography A), Vol. 5, No. 4, 600-9 (Jan.-Feb., 1961)].

SYMMETRY OF CHAIN MOLECULES. see Abstr. 14137

15028 STRUCTURE FACTOR COMPUTING MACHINE. A.Línek and C.Novák.

ech. J. Phys., Vol. 10, No. 5, 397-404 (1960).

A machine has been constructed to calculate functions of the e $A(hkl) = \Sigma f \cos 2\pi/1024[hx + ky + lz]$ and the corresponding e function. It is based on three 24 position selector switches and me standard punched card equipment. J.Iball

15029 DIFFRACTOMETER MEASUREMENT OF LOW-ORDER POWDER REFLEXIONS. P.M.de Wolff.

ta cryst. (Internat.), Vol. 13, Pt 10, 835-7 (Oct., 1960).

"Lattice-parameter determination", Conference paper, ckholm, 1959 (see Abstr. 11550 of 1961). A transmission type ray diffractometer with a focussing monochromator makes it ssible to eliminate specimen-displacement errors by measuring e profiles for two positions of the specimen 180° apart. Values 2 θ can be obtained which are accurate to a few thousandths of degree and therefore precise lattice spacings can be determined om low-angle reflections. J.Iball

15030 A CONTRIBUTION TO THE THEORY OF THE TRIPLE CRYSTAL DIFFRACTOMETER.

Bubáková, J.Drahokoupil and A.Fingerland.
ech. J. Phys., Vol. 11, No. 3, 205-22 (1961).

A general equation is given for a triple-crystal arrangement th perfect crystals on the assumption that the third crystal is tated. It is shown that in the case of perfect crystals the shape of the reflection curve is practically independent of the vertical divergence. The case of mosaic crystals is also solved and the possibility of rotation by other than the third crystal is considered. A method is proposed for investigating the imperfection of a crystal which is different from methods used up to now. The paper is supplemented by some experimental results.

15031 A SIMPLE DIFFRACTOMETER FOR MONOCRYSTALS TO BE USED WITH THE URS-501 X-RAY UNIT.

V.I.Ivanov.
Kristallografiya (USSR), Vol. 5, No. 5, 783-7 (Sept.-Oct., 1960).
In Russian.

An adapter for the GUR-3, which makes it possible to use the URS-501 X-ray unit as a diffractometer for monocrystals, is described. A method for determining the setting angles ω and α and for measuring the reflection intensity is considered. Some of the results obtained with the diffractometer are presented. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 744-8 (March-April, 1961)].

15032 STEPPING MECHANISM FOR X-RAY AND NEUTRON DIFFRACTOMETERS AND SPECTROMETERS.

M.H.Mueller, L.Heaton and E.W.Johanson.
Rev. sci. Instrum. (USA), Vol. 32, No. 4, 456 (April, 1961).

Describes the application of a new type of motor, the "Slo-Syn", to drive an X-ray spectrometer either continuously or in accurate pre-determined steps. The "Slo-Syn" is a permanent magnet a.c. motor provided with two field-coils. When these are energized by alternating current a continuous rotation occurs. When direct current is supplied, the rotor locks into certain well-defined positions. By feeding in suitable pulses, a step-wise operation is obtained which can either be controlled manually or according to a programme. A.E.I. Research Laboratory

15033 THE RATIO METHOD FOR ABSOLUTE MEASUREMENTS OF LATTICE PARAMETERS WITH CYLINDRICAL CAMERAS. M.Černohorský.

Acta cryst. (Internat.), Vol. 13, Pt 10, 823-6 (Oct., 1960).

"Lattice-parameter determination" Conference paper, Stockholm, 1959 (see Abstr. 11550 of 1961). The ratio method (e.g. using two diffraction lines for determining the lattice parameter of cubic crystals) is described and it is shown how to determine a priori the accuracy as a function of the choice of the diffraction lines. This is done for cubic and two-parameter lattices and results are quoted giving an accuracy of 1 part in 10^4 with simple experimental techniques and without extrapolation methods. J.Iball

15034 THE USE OF MONOCHROMATIC X-RAYS FOR THE PRECISION MEASUREMENT OF LATTICE PARAMETERS. H.Barth.

Acta cryst. (Internat.), Vol. 13, Pt 10, 830-2 (Oct., 1960).
In German.

"Lattice-parameter determination" Conference paper, Stockholm, 1959 (see Abstr. 11550 of 1961). A review of the work done on accurate lattice parameter measurements using crystal-monochromatized X-rays. The advantages and disadvantages compared with filtered X-rays are pointed out and the conditions required for the best use of this technique are discussed in detail. J.Iball

15035 APPLICATION OF ANALYSIS BY MEANS OF X-RAY DIFFRACTOMETRY. M.Guillaume.

Bull. Soc. Roy. sci. Liege (Belgium), Vol. 30, No. 7-8, 340-66 (1961). In French.

It is possible with a transmission X-ray diffractometer to determine the composition of crystalline mixture with an accuracy of 2%. The method is applied to two mixtures (1) β-calcium pyrophosphate - β-tricalcium phosphate, (2) calcium hydroxylapalite - β-tricalcium orthophosphate. It is pointed out that reliable results can only be obtained if careful attention is paid to several factors, e.g. (1) the standard and unknown mixture should be ground to the same fineness, (2) suitable peaks should be selected for the particular sample, (3) accurate correction must be made for varying peak heights. J.Iball

15036 AN APPARATUS FOR TURNING CRYSTALS CYLINDRICAL. G.E.Pringle.

Proc. Leeds. Phil. Lit. Soc. (GB), Vol. 8, Pt 6, 177-9 (Feb., 1960).

The crystal is rotated in a lathe and is turned down by a jet of nitrogen carrying alumina or other abrasive powder. Diameters down to 0.1-0.2 mm were obtained. The method failed with diamond and pentaerythritol, but worked on most other crystals.

A.R.Stokes

15037 METHOD FOR MANIPULATING REACTIVE CRYSTALS FOR X-RAY ANALYSIS.

J.Kumamoto, J.A.Ibers and R.G.Snyder.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 362 (March, 1961).

The crystals to be studied are prepared in a reaction tube which is then opened up under an oil. The oil used is a long-chain paraffin which is flushed with nitrogen or argon if the absence of oxygen is necessary and dried with $AlCl_3$ or P_2O_5 followed by silica gel. The crystals thus protected can be spread out on the bottom of a Petri dish and examined in the customary way with a microscope before being packed into an oil-filled tapered capillary tube of dimensions such that the crystal can be wedged tightly against the glass when pushed down with a glass rod. W.Good

15038 SMALL-ANGLE DIFFRACTION WITH ELECTRON BEAMS. H.Mahl and W.Weitsch.

Z.Naturforsch. (Germany), Vol. 15a, No. 12, 1051-5 (Dec., 1960). In German.

The AEG-Zeiss electron microscope was modified to act as an electron diffraction camera of high resolving power. The effective camera length L is 470 cm and the resolving power (ratio of zero-order spot diameter to L) is 3×10^{-6}, so that spacings as large as 800-1000 A should be observable. Examples are shown of diffraction patterns from evaporated metal and other films on various substrates, and of a few organic materials such as perlon and collagen. The longest spacing measured is the 640 A period in collagen. The small-angle patterns are directly visible on the fluorescent screen and may be photographed with an exposure time of a few seconds only, in contrast to the weak intensities of the corresponding X-ray diffraction patterns. Possibilities of further improving the technique are briefly discussed. V.E.Cosslett

15039 AN EXPERIMENTAL METHOD OF CORRECTING FOR EXTINCTION IN CRYSTALS. S.Chandrasekhar.

Acta cryst. (Internat.), Vol. 13, Pt 8, 588-94 (Aug., 1960).

Deals with an experimental method of correcting for extinction errors by the use of polarized X-rays. It involves an accurate study of the variation of the integrated reflection with angle of polarization. The theory and limits of applicability are discussed in detail. It is shown experimentally that the method is feasible when intensity measurements are made with high precision. The principal merit of the technique is that it accounts in certain circumstances for both primary and secondary extinction simultaneously in a crystal of any shape. See also following abstract.

15040 CORRECTION FOR EXTINCTION ERRORS IN CRYSTAL STRUCTURE ANALYSIS.

S.Chandrasekhar and D.C.Phillips.
Nature (GB), Vol. 190, 1164-6 (June 24, 1961).

The author's method (see preceding abstract) was tested by measurements on rocksalt, and on hexamethylene tetramine before and after liquid-air thermal shock treatment. A.R.Stokes

15041 SOME SOURCES OF ERROR IN PRECISION DETERMINATION OF LATTICE PARAMETERS. M.E.Straumanis.

Acta cryst. (Internat.), Vol. 13, Pt 10, 818-21 (Oct., 1960).

"Lattice - parameter determination" Conference paper, Stockholm, 1959 (see Abstr. 11550 of 1961). A discussion of the errors which arise in measuring lattice spacings by X-ray diffraction and of the methods which can be used to reduce them. Under certain specified conditions an accuracy of 1 : 200 000 can be obtained. J.Iball

15042 DISCUSSION OF ERROR IN LATTICE PARAMETER MEASUREMENTS. H.Weyerer.

Acta cryst. (Internat.), Vol. 13, Pt 10, 821-3 (Oct., 1960).

"Lattice-parameter determination" Conference paper, Stockholm, 1959(see Abstr. 11550 of 1961). The errors in spacing measurement are classified under two headings, random errors and systematic errors. The theory underlying several methods of correction is examined and some pitfalls are pointed out. J.Iball

15043 THE REFRACTION CORRECTION IN LATTICE PARAMETER MEASUREMENTS WITH POWDER SPECIMENS. M.Wilkens.

Acta cryst. (Internat.), Vol. 13, Pt 10, 826-8 (Oct., 1960). In German.

"Lattice-parameter determination" Conference paper, Stockholm, 1959 (see Abstr. 11550 of 1961). A discussion of
effect of the refractive index of X-rays on precise lattice pa
meter measurements. The error due to refraction lies betw
two limiting values: their difference at high values of θ is s
but increases as θ decreases. Various extrapolation function
tested and $(\frac{\pi}{2} - \theta)^2$ appears to give the best straight line.

15044 THE INTENSITY DISTRIBUTION IN THE FOCUS CURVED-CRYSTAL MONOCHROMATORS AND A ESTIMATE OF ITS INFLUENCE ON PRECISION MEASUREM OF LATTICE PARAMETERS. J.Čermák.

Acta cryst. (Internat.), Vol. 13, Pt 10, 832-5 (Oct., 1960).

"Lattice-parameter determination" Conference paper, Stockholm, 1959 (see Abstr. 11550 of 1961). An investigation
effect on the distribution of reflected X-ray wavelengths of th
accuracy of alignment of a curved crystal monochromator. It
concluded that such monochromators should only be used for
comparison of parameters and not for absolute measurements

15045 EFFECT OF INCOHERENT WAVES ON THE ELECTRON MICROSCOPIC IMAGES OF CRYSTA

Y.Kamiya and R.Uyeda.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1361-6 (July, 1961).

The electron micrographs of crystalline specimens were
by placing the aperture of the objective lens at various positio
Extinction contours, equal-thickness fringes and dislocation i
were observed under a condition that none of the coherent wav
the transmitted and diffracted waves—entered the aperture. T
implied that the above contrast effects are formed by incohere
waves which are neglected in current theories of diffraction

15046 THE TEMPERATURE RISE OF SPECIMENS IN ELECTRON DIFFRACTION. S.Yamaguchi.

Z. angew. Phys. (Germany), Vol. 13, No. 5, 235-6 (May, 1961). In German.

The temperature sensitivity of the magnetic induction of i
and nickel is used to determine temperature rise in the electr
diffraction camera. A magnetized particle of an iron—nickel a
("Invar") is used as the specimen. Changes of magnetic induct
are then revealed by a measurable shift in the diffracted beam
These shifts can be related to the Curie temperature. Specime
temperatures of 300-400° C were deduced in this way.

A.E.I. Research Labor

15047 A SIMPLE METHOD FOR THE DETERMINATION $\partial^2\rho/\partial x^2$ AT ATOMIC POSITIONS. H.W.Ehrlich.

Acta Cryst. (Internat.), Vol. 13, Pt 11, 960-2 (Nov., 1960).

Assuming (1) that the electron density near the centre of a
atom closely resembles $\rho = Z\,(p/\pi)^{3/2}\,\exp(-px^2)$, where Z is t
atomic number and p is usually between 3 and 5, and (2) that
shape of an atom from Fourier synthesis is independent of the
of the unit cell, a formula for $\partial^2\rho/\partial x^2$ is derived and the factor
governing its accuracy are discussed. R.F.S.Hea

15048 STUDY OF THE ANOMALOUS TRANSMISSION OF X-RAYS IN CRYSTALS OF SILICON. I. PERFECT CRYSTALS. A.Authier.

Bull. Soc. Franc. Mineral. Crist., Vol. 84, No. 1, 51-89 (Jan.-March, 1961). In French.

Surveys the dynamic theory of the diffraction of X-rays assuming the incident wave to be plane and infinite. The conclu
are tested experimentally, using single crystals of Si. J.Th

15049 STUDY OF THE ANOMALOUS TRANSMISSION OF X-RAYS IN CRYSTALS OF SILICON. II. APPLIC TO IMPERFECT CRYSTALS. A.Authier.

Bull. Soc. Franc. Mineral. Crist., Vol. 84, No. 2, 115-27 (April-June, 1961). In French.

By using a divergent beam of X-rays according to the
technique described by Lang, Borrman, and others, it was poss
to observe dislocation lines in Si crystals. If the dislocation is
the exit face a double trace (black and white) is obtained on the
if the dislocation is situated in the body of the crystal a triple

e (black-white-black) occurs. A theoretical model is described :h explains the results and permits the order of magnitude of deformation field to be estimated at some distance from a ocation. J.Thewlis

5050 THE INFLUENCE OF THE SPECTRAL PROFILE OF THE $K\alpha_1\alpha_2$ DOUBLET AND DIFFRACTION BROADEN- ON THE INTEGRATED INTENSITIES OF HIGH ANGLE RACTIONS.

A.Kochanovská.

:h. J. Phys., Vol. 11, No. 1, 21-33 (1961). In Russian.

Relations are derived giving the influence of the spectral ile of the $K\alpha_1\alpha_2$ doublet and the influence of diffraction broaden- on the product LP of the Lorentz and polarization factor. The tions are used to calculate the numerical values of the corres- ling corrections for the theoretical values of the integrated nsities of diffractions in the angular region $75^\circ \leq \theta \leq 85^\circ$ and the most frequently used $K\alpha$ radiation of copper, cobalt and iron. llows from the calculated values of the corrections that, due to accuracy at present attainable in experimental measurements, the ence of the spectral profile in diffractions with an angle $\theta < 80^\circ$ be neglected when calculating the theoretical values of the grated intensities. The influence of diffraction broadening need be taken into account in diffractions with an angle $\theta < 83^\circ$ even n the broadening is large (e.g. five-fold). As the angle approach- 0°, of course, the corrections for both above influences suddenly ease, particularly those for diffraction broadening, and their itation becomes difficult and is not single-valued. For this reason use of diffractions with angles $\theta > 83^\circ$ does not appear very able for solving problems based on exact measurement of the grated intensities and their comparison with the corresponding retical values.

15051 P_S FUNCTION IN ELECTRON DIFFRACTION.

Y.Kainuma.and W.N.Lipscomb.

Phys. Soc. Japan, Vol. 26, No. 3, 495-500 (March, 1961).

The property if the P_S function in electron diffraction was died on the basis of the dynamical theory of diffraction. It was ved that the P_S function in electron diffraction has the property ilar to the P_S function in X-ray diffraction, as expected from udo-kinematical theory, i.e. kinematical theory using the complex mic scattering factor.

15052 THEORY OF THE DEBYE ATTENUATION FACTOR FOR REGULAR REFLECTIONS IN REAL CRYSTALS.

A.Krivoglaz.

istallografiya (USSR), Vol. 4, No. 6, 813-20 (Nov.-Dec., 1959). Russian.

Deals with the attenuation caused by thermal and random splacements of the atoms in a real crystal. It is assumed that probability of a displacement does not follow a Gaussian law. is found that the exponent in the attenuation factor depends in a mplicated way on the diffraction vector (not on the square of at vector, as in ideal crystals). This deviation from a square- w relation should be apparent if there are lattice distortions ar defects. A discussion is given of effects caused by groups of fects. [English translation in: Soviet Physics—Crystallography SA), Vol. 4, No. 6, 775-80 (June, 1960)].

15053 MEASUREMENT OF ELECTRON DIFFRACTION INTENSITIES OF POLYCRYSTALLINE ALUMINIUM LMS AND COMPARISON WITH THE KINEMATIC AND DYNAMIC ATTERING FORMULAE.

M.Horstmann and G.Meyer.

aturwissenschaften (Germany), Vol. 48, No. 2, 41-2 (1961). German.

Describes new measurements of the ring intensities from an uminium film in which the grain size was progressively increased suitable heat treatment. Inelastically scattered electrons could removed by a filter. For grain size less than 80 A good agree- ent with kinematic theory was obtained but for larger grain sizes is theory proved inadequate. The dynamical theory however ave good agreement with the experiments even for a grain size 200 A. A.E.I.Research Laboratory

15054 EFFECT OF GEOMETRICAL DISTORTIONS OF THE CRYSTAL LATTICE ON X-RAY AND THERMAL EUTRON SCATTERING BY MULTICONSTITUENT DISORDERED LID SOLUTIONS.

M.O.Kry̆voglaz and O.O.Ty̆khonova.

krayin. fiz. Zh. (USSR), Vol. 3, No. 3, 297-313 (1958). In Ukrainian.

The scattering of X-rays and thermal neutrons by multiconsti- ent solutions of arbitrary composition and arbitrary values of the hort-range order is discussed, taking into consideration geometri- al distortions. Formulae are obtained that permit the determination of the intensity of diffuse scattering and weakening of the regular reflection intensity by means of independent experimental data on the concentration dependence of the dimensions and shape of the unit cell, on the moduli of elasticity and on the concentration dependence of the chemical potentials (or on the correlation parameters). An investigation is made of the dependence of scattering intensity of the concentration of the constituents, the correlation parameters and on the difference between the wave vectors of the diffuse and incident waves.

DETERMINATION OF THE ELASTIC CONSTANTS OF TETRAGONAL $(4, \bar{4}, 4/m)$ CRYSTALS FROM THE STUDY OF DIFFUSE X-RAY REFLECTIONS. See Abstr. 14842

15055 PHOTOELECTRIC METHOD FOR DETERMINING INTERFACE SHAPE IN GERMANIUM MONOCRYSTALS.

A.Brochocki and J.Świderski.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 9, 537-41 (1960).

In preparing germanium monocrystals with optimum physical properties it is important to obtain a flat interface between solid and liquid phases of the crystallizing material. A change of impurity concentration can be produced as required, in the course of pulling, by changing the speed of rotation of the crystal, and experiments prove that such a change in impurity concentration occurs across the whole interface. A change in resistance produced in this manner is used to provide a sudden change in photoelectric effect along the axis of the crystal. So, by employing a method based on the bulk photovoltaic effect the above sudden change in resistance could be detected and the solid—liquid interface shape is determined. This method should be generally applicable and is not limited to germanium monocrystals. F.A.Baker

15056 THEORETICAL STUDY OF THE EFFECT ON DEBYE—SCHERRER DIAGRAMS OF INTERCHANGE FAULTS IN SMALL HOMOGENEOUS FACE-CENTRED-CUBIC CRYSTALS.

P.Larroque and Nguyen Quat Ti.

C. R. Acad. Sci. (France), Vol. 252, No. 17, 2537-9 (April 24, 1961). In French.

The interchange of atoms in a face-centred cubic crystal produces atomic sequences, and hence Debye—Scherrer photographs, resembling those of a completely different crystal structure. It is thus difficult by means of powder diffraction patterns to distinguish between richness in faults and actual structural change.

A.E.I. Research Laboratory

15057 INVESTIGATION OF THE WIDTH OF X-RAY LINES IN ALUMINIUM DEFORMED AT 4.2°K.

O.V.Klyavin and V.I.Smirnov.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1335-7 (May, 1961). In Russian.

The widths of the 200 and 400 lines in aluminium deformed at 4.2, 77 and 300°K were determined as a function of extensional deformation. The line widths increase with decreasing deformation temperature, indicating growth of micro-faults and increasing granulation of the blocks. Data on the narrowing of the lines with time of storage at 300°K are also given. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 967-9 (Nov., 1960)].

R.F.S.Hearmon

15058 DIFFUSE SCATTERING OF X-RAYS BY QUARTZ CRYSTALS BEFORE AND AFTER NEUTRON IRRADIATION.

E.V.Kolontsova and L.A.Ignat'eva.

Kristallografiya (USSR), Vol. 4, No. 6, 821-5 (Nov.-Dec., 1959). In Russian.

A comparison was made of the intensity and form (in reciprocal lattice space) of the regions of diffuse scattering from quartz monocrystals before and after neutron irradiation. After irradiation of the crystals with 10^{17} and 10^{18} neutrons/cm^2, the diffuse scattering did not differ from the thermal scattering from a non-irradiated crystal; after irradiation with 10^{19} neutrons/cm^2 the form of the scattering maxima was unchanged, but their intensity was increased about one-and-a-half times. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 781-5 (June, 1960)].

15059 THE EFFECT OF STACKING FAULTS ON THE INTENSITY OF THE DEBYE LINES.

V.I.Iveronova, I.I.Popova and G.P.Revkevich.

Kristallografiya (USSR), Vol. 5, No. 4, 530-4 (July-Aug., 1960). In Russian.

The selective decrease of the line intensity on the Debye crystallogram of the deformed and annealed powder of β-brass containing stacking faults is discussed. The probability of the appearance of stacking faults is determined from the line broadening. The observed decrease of the intensity is in accordance with that calculated according to Wilson's theory. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 509-12, (Jan.-Feb., 1961)].

15060 THE THEORY OF X-RAY AND THERMAL NEUTRON SCATTERING BY MULTICOMPONENT [UNORDERED] SUBSTITUTIONAL ALLOYS.

A.A.Smy̆rnov and E.A.Ty̆khonova.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 322-33 (1959). In Ukrainian.

The authors consider the effect of geometrical distortions of the lattice, connected with the difference of the atomic radii of various components, on the scattering of X-rays and thermal neutrons. The model of an elastic continuum is accepted. It is also assumed that the law of displacement superposition holds true, i.e. that the displacement of each atom under the action of all the rest is the vector sum of the displacements caused by each separate atom. The concentration dependence is investigated both of the intensity of true reflections and of the intensity of the background in monochromatic ray scattering by a monocrystal. The special cases of binary and ternary alloys are discussed. For binary systems the value of M, which characterizes the weakening of true reflections, depends on the intensity of c_A in accordance with a parabolic law, if the alloy volume is linearly dependent on the concentration. Geometrical distortions of the lattice disturb the parabolic nature of the changes in background intensity with changes in the concentration. If, however, the alloy volume is linearly dependent on the concentration, and the atomic factors of the scattering of atoms A and B are equal, the background intensity again becomes parabolically dependent on the concentration c_A. In the case of ternary alloys, the addition of a third component may — depending on the ratio of the atomic radii and the concentrations of the A, B and C components — either increase the intensity of the true reflections and decrease the background intensity as compared with the I^o_{tr} and I^o_b in binary alloys, or decrease the true reflection intensity and increase the background intensity. The ratios of atomic volumes leading to one or the other result are established.

15061 DETERMINATION OF LATTICE PARAMETERS WITH THE AID OF A COMPUTER.

M.H.Mueller, L.Heaton and K.T.Miller.
Acta cryst. (Internat.), Vol. 13, Pt 10, 828-9 (Oct., 1960).

"Lattice-parameter determination" Conference paper, Stockholm, 1959 (see Abstr. 11550 of 1961). A programme for the determination of lattice parameters and standard errors was written for the Argonne GEORGE and for the IBM-704 digital computers. It uses the method of least squares and is applicable to the orthorhombic system and all other crystal systems of higher symmetry. One, two, three or no correction terms can be included and if desired, a weighting factor for each reflection can be used. It was found in practice that a weighting factor usually gives a better fit and a smaller standard error and it was not found necessary to use an iterative method since the convergence is very rapid even though the starting values of the parameters are in error by a factor of ten. J.Iball

15062 A UNIFIED PROGRAM FOR PHASE DETERMINATION, TYPE $3P_3$.

H.Hauptman and J.Karle.
Acta cryst. (Internat.), Vol. 13, Pt 10, 745-8 (Oct., 1960).

The unified programme for phase determination, valid for all the space groups and both the equal and unequal atom cases is continued here. The present paper is concerned with the centrosymmetric space groups comprising type $3P_3$. A detailed procedure for phase determination is described for this type.

15063 FORMULAE FOR MODULATED ELECTRON DENSITY PROJECTIONS FOR PLANE OBLIQUE-ANGLED AND RECTANGULAR BLACK-WHITE GROUPS HAVING A CENTRE OF SYMMETRY (ANTISYMMETRY).

I.M.Rumanova.
Kristallografiya (USSR), Vol. 5, No. 6, 831-63 (Nov.-Dec., 1960). In Russian.

For all 74 space groups of the lower systems, Fourier expansion formulae are derived for those functions of modulated electron density projections, the symmetry of which is described by plane black-white groups having a centre of symmetry or antisymmetry. [English translation in: Soviet Physics — Crystallography (USA), Vol. 5, No. 6, 793-825 (May-June, 1961)].

15064 DEDUCTION OF THERMAL ANISOTROPY PARA
METERS FROM THE ELECTRON DENSITY DISTRIBUTION.

M.Nardelli and G.Fava.
Ricerca sci. (Italy), Vol. 30, No. 6, 898-903 (June, 1960). In

Describes an approximation method for carrying out this
calculation, which uses relations given in Abstr. 7632 of 1959
method is tested on a hypothetical lattice and works reasonab
The peak electron densities and their curvatures needed for a
the method are tabulated for C, N, O, S, Cl^-, Ni^{++}, Se and Br
J.H

15065 DESIGN OF A FUNCTION GENERATOR FOR ATO
SCATTERING FACTORS.

P.V.Venkatakrishnan.
J. sci. industr. Res. (India), Vol. 20 B, No. 3, 89-92 (March, 1

The two-term Gaussian expansion for the atomic scatter
factors is synthesized by using an exponential function genera
The input consists of $\sin^2\theta$ values fed in as a d.c. voltage and
output is a d.c. voltage proportional to the f (atomic scatterin
function) value. The f values of different atoms can be obtain
a simple selection of resistances. The estimated maximum e
is 1% and the setting time per f value per atom is of the orde
of 0.3 sec. The exponential function generator used in this de
is based on an interpolation using the Taylor expansion; the
accuracy is 0.32% f.s. using 0.1% tolerance components. An
extension of this method to hyperbolic function generation is
indicated.

15066 STANDARD X-RAY DIFFRACTION POWDER PATTERNS. VOL. 9. DATA FOR 43 SUBSTANC

H.E.Swanson, M.I.Cook, T.Isaacs and E.H.Evans.
Circ. Nat. Bur. Stand. (USA), Circ. 539 (Vol. 9), 64 pp. (1960)

Forty-three standard X-ray diffraction powder patterns
presented. Thirty-one are to replace forty-one patterns alre
given in the X-ray Powder Data File, and twelve are for subs
not previously included. The X-ray Powder Data File is a
compilation of diffraction patterns from all sources and is us
for the identification of unknown crystalline materials by mat
spacing and intensity measurements. In this Circular, compa
is made of all powder diffraction data available for each of th
substances reported. The patterns were made with a Geiger
counter X-ray diffractometer, using samples of high purity.
d-values were assigned Miller indices determined by compar
with calculated interplanar spacings and from space group co
siderations. The densities and lattice constants were calcula
and the refractive indices were measured whenever possible.
Included are X-ray data for the following forty-three substan
α-Al_2O_3 (corundum), NH_4N_3, $(NH_4)HCO_3$ (teschemacherite),
$(NH_4)_2PtBr_6$, NH_4ReO_4, $(NH_4)_2SO_4$ (mascagnite), $BeAl_2O_4$
(chrysoberyl), $Be_3Al_2(SiO_3)_6$ (beryl), BiOI, $CdBr_2$, $CdCl_2$,
$12CaO.7Al_2O_3$, $Ca_3Fe_2Si_3O_{12}$ (andradite), Cs_2TeBr_6, $CsNO_3$, β-
$CoAl_2O_4$, CoO, Co_3O_4, Dy_2O_3, $ErPO_4$, Ho_2O_3, $MgCr_2O_4$ (picroch
$MnAl_2O_4$ (galaxite), $MnFe_2O_4$ (jacobsite), Mn_2O_3 (partridgeite)
HgO (montroydite), $Nd[(C_2H_5)SO_4]_3.9H_2O$, $NiAl_2O_4$, Ni_2GeO_4, KB
$K_3Co(NO_2)_6$, K_3ZrF_7, PrOCl, γ-AgI, $AgIO_4$, $NaBH_4$, $SrZrO_4$, S,
(tellurite), Tm_2O_3, $TiO_{1.515}$, and ZnI_2.

15067 STANDARD X-RAY DIFFRACTION POWDER PATTERNS. VOL. 10. DATA FOR 40 SUBSTAN

H.E.Swanson, M.I.Cook, E.H.Evans and J.H.deGroot.
Circ. Nat. Bur. Stand. (USA), Circ. 539 (Vol. 10), 61 pp. (196

Forty standard X-ray diffraction powder patterns are pr
sented. Twenty-two are to replace thirty-five patterns alrea
given in the X-ray Powder Data File, and eighteen are for su
stances not previously included. Included are X-ray data for
following forty substances: $AlPO_4$ (berlinite), $AlPO_4$, Sb_2O_3
(natural valentinite), Sb_2O_3 (synthetic valentinite), Sb_2O_4 (cerv
Sb_2O_5, $BaCO_3$, $BeCr_2O_4$, Be_2GeO_4, $Ca_3Al_2(GeO_4)_3$, $Ca_3Cr_2(GeO_4$
$Ca_3Cr_2(SiO_4)_3$ (uvarovite), $Ca_3Ga_2(GeO_4)_3$, $Ca_3Fe_2(GeO_4)_3$,
$Ce_2Mg_3(NO_3)_{12}.24H_2O$, $CoAs_3$ (skutterudite), $CoAs_2$, $CoGa_2O_4$,
Co_2GeO_4, $CoFeAs_4$ (safflorite), $CoCO_3$ (sperocobaltite), $Cu_3(OH$
(azurite), $Cu_2(OH)_2(CO_3)$ (malachite), AuCN, $FeAs_2$ (loellingite
$MgGa_2O_4$, Mg_2GeO_4 (cubic), Mg_2GeO_4 (orthorhombic), Mg_2SiO_4
(norbergite), MnSe, $NiAs_2$ (rammelsbergite), $NiFe_2O_4$ (trevor
$NiGa_2O_4$, K_2RuCl_6, $K_4Ru_2Cl_{10}O.H_2O$, SiO_2 (cristobalite), Ag_2S
(argentite), α-$Na_4P_4O_{12}.4H_2O$, TeO_2, paratellurite, Zn_2GeO_4.

15068 RESULTS OF THE I.U.Cr. PRECISION LATTICE PARAMETER PROJECT.

W.Parrish.
Acta. cryst. (Internat.), Vol. 13, Pt 10, 838-50 (Oct., 1960).

"Lattice-parameter determination" Conference paper,
Stockholm, 1959 (see Abstr. 11550 of 1961). Sixteen laborato

ine countries co-operated in a project sponsored by the ernational Union of Cystallography to compare the lattice-parameters determined in the different laboratories for samples of mond, silicon and tungsten. A report of the results is presented the lattice parameters found for the three substances are ulated. The percentage spread of the reported mean values for h of the three substances was approximately 0.01. J.Iball

15069 SINGLE CRYSTAL DIFFRACTION PATTERN OF GERMANIUM.

ubáková, J.Drahokoupil and A.Fingerland.
ech. J. Phys., Vol. 11, No. 3, 199-204 (1961).

The diffraction pattern for the (111)-reflection of germanium was asured by means of the three-crystal arrangement and compared h dynamical theory. The results obtained indicate the possibility using germanium crystals for precise measurements in X-ray

15070 DIFFERENT LATTICE CONSTANTS OF SOLID NEON ISOTOPES.

.Kogan, B.G.Lazarev and R.F.Bulatova.
. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 29-31 (Jan., 1961).
Russian.

X-ray diffraction investigations of Ne^{20} and Ne^{22} were performed 4.2°K. Both isotopes have face-centred cubic lattices, with the nstants $a = 4.471 \pm 0.004$ A and 4.455 ± 0.004 A, respectively. e relative difference in the molar volumes, $\Delta V/V = 1.1 \pm 0.5\%$, rees satisfactorily with calculations taking into account the ference in zero-point vibration energy. The difference in the lar volumes of the neon isotopes is much greater than that for hium isotopes, which, according to the literature, is negligible spite the larger relative mass difference of the latter. This is parently associated with a difference in the nature of the binding ces in neon and lithium lattices. [English translation in: Soviet ysics—JETP (USA), Vol. 13, No. 1, 19-20 (July, 1961)].

NEW ALLOTROPIC FORM OF He^3. See Abstr. 13039

EFFECT OF Ga FILM ON STRUCTURE OF Zn, Cd AND Sn. e Abstr. 14910

15071 ON DEFORMATION OF ELECTRON CLOUDS IN SOME IONIC CRYSTALS. U.Korhonen and S.Vihinen.

n. Acad. Sci. Fennicae A VI (Finland), No. 73, 8pp. (1961).

It is shown on the basis of the experimental structure factor lues measured by Vihinen (Abstr. 18350 of 1960), that a slight formation appears in the electron distribution of the Cl^- ion in e NaCl crystal. This deformation, which depends on the crystalloaphic direction, fulfils the physical conditions very well, being rongest in the directions where the ions with unlike signs are jacent. Besides, the negative ion is slightly compressed, whereas e positive ion is to some degree enlarged. The same findings ere made in the electron distribution of the K^+ ion in the trigonal NO_3 crystal.

15072 ON THE ELECTRON DENSITY DISTRIBUTIONS IN IONS OF NaCl, KCl, AND RbCl CRYSTALS. K.Mansikka.

nn. Acad. Sci. Fennicae A VI (Finland), No. 81, 44 pp. (1961).

The electron density distributions in ions of NaCl, KCl, and bCl crystals were determined from experimental structure factors means of the Fourier integral method. It is shown that the perimental structure factors, and also the electron density nctions of the ions, can be expressed to a fairly good approximaon as a sum of spherically symmetrical Gaussian distribution nctions. The determination of the mean-square displacements of e vibrating ions was investigated by using two different methods. he values obtained for the mean-square displacements of the ions ere used for separating the effect of atomic vibrations from the lectron density distributions. Numerical values of the radial ensity functions were compared with those determined theoretically y Hartree for the isolated ions. The radial density curves of ifferent ions are represented in four diagrams.

15073 SUB-STRUCTURES IN SILVER BROMIDE CRYSTALS.

H.Chateau and A.De Cugnac.
. Phys. Radium (France), Vol. 21, No. 11, 789-93 (Nov., 1960).
French.

Several monocrystals of silver bromide were analysed by onochromatic X-ray diffraction. The shape of these crystals is ery regular, nevertheless the diffraction patterns show the presence f a great number of substructures in every crystal. According to e patterns, each crystal consists of a regular lattice in which there are small crystallites. These crystallites are oriented around the 110 axis of the perfect crystal and the angles of rotation are generally less than 10°, but in some cases, they reach 26°. The substructures appear in darkness during the growth of crystals or, also, when light causes blackening of the crystals.

15074 A DIFFUSE REFLEXION FROM A SILICON CARBIDE CRYSTALS. T.Tomita.

J. Phys. Soc. Japan, Vol. 15, No. 8, 1540-1 (Aug., 1960).

A diffuse streak is obtained on a c-axis oscillation photograph. An explanation is suggested in terms of layer stacking sequences.

A.R.Stokes

15075 . 222-REFLECTION FROM CuCl IN ELECTRON DIFFRACTION. F.Fujimoto.

J. Phys. Soc. Japan, Vol. 16, No. 5, 936-43 (May, 1961).

The 222-reflection of electron diffraction from CuCl was theoretically and experimentally studied. The ratio of the integrated intensity of the 222-reflection to that of the 111-reflection is calculated by expansion of the scattering matrix and by the solution of Mathieu equation. Calculated results by both methods agree sufficiently with each other up to the grain size 140 A for 41.3 kV electrons. The CdS detector and, in addition, the CdS monitor were used in the intensity measurement. The experimental values of the integrated intensity were found to be smaller than the theoretical values at small grain sizes of crystallites. It is, however, confirmed that the ratio of integrated intensity of the 222-reflection to that of the 111-reflection is nearly proportional to the square of grain size and the wavelength, in qualitative accordance with theory. The 420-reflection was also measured. Dependence of the integrated intensity on wavelength is the same as that of the 222-reflection.

15076 ON THE STRUCTURE OF ZnSb. K.Toman.

J. Phys. Chem. Solids (GB), Vol. 16, No. 1-2, 160-1 (Nov., 1960).

The structure was redetermined using intensity data obtained from a monochromatized X-ray powder diffraction pattern. It is similar to Almin's structure [Acta Chemica Scandinavica (Denmark), 2, 400 (1948)], but the Zn—Zn distance is 2.82 A instead of 2.59 A. The bearing of this on semiconducting properties is pointed out.

A.R.Stokes

15077 CRYSTAL STRUCTURES OF SOME COMPOUNDS OF PALLADIUM WITH MAGNESIUM.

P.I.Kripyakevich and E.I.Gladyshevskii.
Kristallografiya (USSR), Vol. 5, No. 4, 577-9 (July-Aug., 1960).
In Russian.

In the Pd—Mg system two compounds have been found, PdMg (CsCl-type, $a = 3.16 \pm 0.01$ kX) and $Pd_{1.1}Mg_{0.9}$ (AuCu-type, $a = 3.02 \pm 0.01$, $c = 3.41 \pm 0.01$ kX, $c/a = 1.13$; space group $P4/mmm = D_{4h}^1$, 1 Pd in 1 (a), 0.9 Mg + 0.1 Pd in 1 (d)). The ratio c/a diminishes in the series of AuCu-type compounds of Pd with Hg, Cd, Zn and Mg. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 552-4 (Jan.-Feb., 1961)].

15078 STUDY OF CHROMIUM SELENIDES.

M.Chevreton and F.Bertaut.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 145-7 (July 3, 1961).
In French.

Cr_3Se_4 is monoclinic, with $\beta = 91°\,28'$; Cr_7Se_8 is monoclinic with $\beta = 90°\,57'$. Cell dimensions and atomic positions are given.

A.R.Stokes

15079 ANOMALOUS TEMPERATURE DEPENDENCE OF LATTICE CONSTANT OF CrO_2.

K.Siratori and S.Iida.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2362-3 (Dec., 1960).

Describes results of measurements of crystal distortion in CrO_2 and $Mn_xCr_{1-x}O_2$ caused by temperature changes between −150 and 200°C, with an explanation in terms of Jahn—Teller distortion of $(3d)^2$ orbitals of Cr^{4+}. J.Hawgood

15080 AN EFFECT OF HEAT TREATMENT ON WO_3 SINGLE CRYSTAL. I. VARIOUS PATTERNS.

T.Horie and T.Iwai.
J. Phys. Soc. Japan, Vol. 16, No. 3, 424-9 (March, 1961).

After having been heated in vacuum with or without metallic vapour at a reduced pressure, WO_3 single crystals show various patterns, i.e. a pattern composed of green stripes, a bluish splashed pattern, a pattern of dark lines, and so on. Each of them has its own habits of orientation with respect to the crystal axes as well as of colour. Which pattern does come out, depends entirely on the condition of heat treatment.

15081 CRYSTAL STRUCTURES AND ELECTRICAL PROPERTIES OF ALKALI ANTIMONIDES.

J.Chikawa, S.Imamura, K.Tanaka and M.Shiojiri.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1175-80 (June, 1961).

Both X-ray study and electrical measurement were simultaneously carried out keeping the specimen in vacuum. In K—Sb and Na—Sb, the crystallization into the hexagonal structure from the amorphous state and the transition from p-type semiconductor to n-type one occur simultaneously with successive activation by alkali metal. But Cs—Sb keeps constantly p-type in spite of the crystallization into the cubic structure from amorphous state. In Rb—Sb, the transition of structure occurs, i.e., amorphous → cubic → hexagonal, and n-type conduction appears in the hexagonal structure. In order to explain these facts, the relation between the excess alkali atoms and the crystal structure was considered. The cubic phase of Rb_3Sb was found to be the same as the structure of Cs_3Sb. The unit cell (a = 8.84 ± 0.02A) is described by the space group $Fd3m\text{-}O_k^7$ with eight rubidium atoms at $(0, 0, 0;\ 0, \frac{1}{2}, \frac{1}{2};\ \frac{1}{2}, 0, \frac{1}{2};\ \frac{1}{2}, \frac{1}{2}, 0) + 0, 0, 0$ and $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$, and four antimony and four rubidium atoms occupying at random the other positions $(0, 0, 0;\ 0, \frac{1}{2}, \frac{1}{2};\ \frac{1}{2}, 0, \frac{1}{2};\ \frac{1}{2}, \frac{1}{2}, 0) + \frac{1}{2}, \frac{1}{2},$ and $\frac{3}{4}, \frac{3}{4}, \frac{3}{4}$.

15082 CRYSTAL STRUCTURE OF $Li_{15}Ge_4$.

E.I.Gladyshevskii and P.I.Kripyakevich.
Kristallografiya (USSR), Vol. 5, No. 4, 574-6 (July-Aug., 1960).
In Russian.

It has been found that the compound Li_4Ge [J. Phys. Chem. Solids (GB), Vol. 3, 74 (1957)] has actually the composition $Li_{15}Ge_4$ and a structure of the $Cu_{15}Si_4$-type (a = 10.761 kX). This structure shows the closest packings of atoms of unequal sizes; it also can be described as a packing of deformed icosahedra $[SiCu_3{}^{(1)}Cu_9{}^{(2)}]$. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 549-51 (Jan.-Feb., 1961)].

15083 ELECTRON-DIFFRACTION STUDY OF W_2C.

L.N.Butorina and Z.G.Pinsker.
Kristallografiya (USSR), Vol. 5, No. 4, 585-8 (July-Aug., 1960).
In Russian.

The structure of hexagonal tungsten carbide is of the cadmium iodide type, in agreement with previous data. The scattering of the electrons from crystals with linear dimensions of about 350 A was observed to be dynamic with sufficient accuracy. The authors succeeded in finding the carbon atom coordinates in spite of the great difference in the scattering power of tungsten and carbon atoms. For the derivation of experimental structure amplitudes and for the determination of the structure, the relation between I and Φ given by the dynamic theory is used. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 560-3 (Jan.-Feb., 1961)].

15084 MANIFESTATION OF MICROISOMORPHISM IN QUARTZ.

V.A.Frank-Kamenetskii.
Kristallografiya (USSR), Vol. 5, No. 4, 650-4 (July-Aug., 1960).
In Russian.

Precision X-ray data are presented for 10 natural and 35 synthetic quartz crystals differing in origin and composition. The lattice parameter variations are: a = 4.9026-4.9038, c = 5.3933-5.3945 kX (synthetic); a = 4.9023-4.9039, c = 5.3923-5.3944 kX (natural). Lattice parameters are compared with impurity contents. It is shown that impurities such as Al, Na, Fe, Mg and Ge cause microisomorphous substitution in the quartz lattice. The unit cell becomes larger with increasing impurity content. Microisomorphous relations act on the growth and morphology of quartz and are also connected with the genetic and paragenetic conditions of natural quartz. [English translation in: Soviet Physics — Crystallography (USA), Vol. 5, No. 4, 622-6 (Jan.-Feb., 1961)].

15085 CRYSTAL STRUCTURE OF THE HIGH-TEMPERATURE FORM OF In_2Se_3.

S.A.Semiletov.
Kristallografiya (USSR), Vol. 5, No. 5, 704-10 (Sept.-Oct., 1960).
In Russian.

Determined by means of electron diffraction. The structure is based on two-layer hexagonal packing of Se atoms (a = 7.11, c = 19.3 A; space group C_6^3—$C6_5$; Z = 6); the In atoms lie in the tetrahedral holes related by sixfold screw axes. The In—Se distance (2.51 A) equals the sum of the tetrahedral covalent radii (2.49 A), which shows that the bonds are principally of the covalent typ [English translation in: Soviet Physics—Crystallography (US Vol. 5, No. 5, 673-8 (March-April, 1961)].

15086 SYNTHESIS AND STUDY OF STRUCTURE II OF HEXAGONAL TUNGSTEN NITRIDE.

V.I.Khitrova and Z.G.Pinsker.
Kristallografiya (USSR), Vol. 5, No. 5, 711-17 (Sept.-Oct., 19
In Russian.

The structure is reported for the hexagonal tungsten nitr having a = 2.89 and c = 22.85 A. The space group is $C\bar{3}$. The coordinates of the W and N atoms have been found by means o and Φ series, including difference series. The tungsten atom in the positions: $2(c)\text{-}00z_1$; $z_1 = 0.0607$; $2(d)\text{-}\frac{1}{3}, \frac{2}{3}, z_2$; $2(d)\text{-}\frac{1}{3}, \frac{2}{3},$ $z_2 = \frac{1}{3} - z_1$; $z_3 = \frac{1}{3} + z_1$. The nitrogen in positions: N : $1(d)\text{-}00\frac{1}{2}$ $2(d)\text{-}\frac{1}{3}, \frac{2}{3}, z$, z = 0.154. The coordination patterns of W and N a examined. [English translation in: Soviet Physics—Crystallo (USA), Vol. 5, No. 5, 679-84 (March-April, 1961)].

15087 X-RAY ANALYSIS OF THE SUPERCONDUCTOR β Bi_3Rh.

R.N.Kuz'min and G.S.Zhdanov.
Kristallografiya (USSR), Vol. 5, No. 6, 869-76 (Nov.-Dec., 19
In Russian.

A complete study is reported for β Bi_3Rh, which is found isomorphous with Bi_3Ni. The positions of the Rh atoms are established directly; the previously proposed formula Bi_3Rh i confirmed. [English translation in: Soviet Physics — Crystal graphy (USA), Vol. 5, No. 6, 830-5 (May-June, 1961)].

15088 X-RAY AND MICROSCOPIC EXAMINATION OF T ALLOYS OF Hf WITH Re.

E.I.Glady̆shevskii, M.A.Ty̆lkina and E.M.Savitskii.
Kristallografiya (USSR), Vol. 5, No. 6, 877-81 (Nov.-Dec., 19
In Russian.

Four compounds have been detected in this system and th structures of two of them determined: Hf_5Re_{24}, structure of t Ti_5Re_{24} type, a = 9.713 ± 0.005 A; $HfRe_2$, structure of the Mg type, a = 5.248 ± 0.001 A, c = 8.592 ± 0.002 A, c/a = 1.637. [English translation in: Soviet Physics - Crystallography (US Vol. 5, No. 6, 836-40 (May-June, 1961)].

15089 URANIUM DISILICIDE.

A.Brown and J.J.Norreys.
Nature (GB), Vol. 191, 61-2 (July 1, 1961).

Crystallographic data are given on $USi_{1.67}$, $USi_{1.88}$, and U Above 450°C, USi_2 breaks up to give $USi_3 + USi_{1.88}$. A.R

15090 A PRELIMINARY STUDY OF THE CRYSTAL STRUCTURE OF LOW TRIDYMITE.

J.E.Fleming and H.Lynton.
Phys. Chem. Glasses (GB), Vol. 1, No. 5, 148-54 (Oct., 1960)

An X-ray investigation of a single crystal of low tridymi extracted from a brick used as a lining for a gas retort was out in order to provide structural information to be used in p ing models for silica glass. The unit cell of low tridymite ap to be hexagonal, with dimensions a = 30.08 A, c = 49.08 A, co 864 SiO_2 units. The diffraction pattern consists of weak and reflections and only the strong reflections which define a he sub-cell of dimensions a = 5.01 A, c = 8.18 A were used in th analysis. Starting with Gibbs's structure for high tridymite a using the method of successive Fourier refinement, a set of a positions for the low tridymite sub-cell has been found. The structural feature to be firmly established is that all Si—O— are bent. This is in agreement with the results found in othe structures.

15091 NEUTRON INVESTIGATION OF THE CUBIC PHA OF PbF_2.

I.I.Yamzin, Yu.Z.Nozik and N.V.Belov
Dokl. Akad. Nauk (USSR), Vol. 138, No. 1, 110-11 (May 1, 19
In Russian.

By comparing experimental and theoretical line intensiti neutron diffraction, it was verified that the high temperature phase of PbF_2 has the CaF_2 structure. [English translation i Soviet Physics—Doklady (USA), Vol. 6, No. 5, 370-1 (Oct., 19
D.J.

15092 THE UNIT CELL AND SPACE GROUP OF GALL IRON OXIDE, A PIEZOELECTRIC FERROMAGN CRYSTAL.

E.A.Wood.
Acta cryst. (Internat.), Vol. 13, Pt 8, 682 (Aug., 1960).

Crystals of $Ga_{2-x}Fe_xO_3$ (with x approximately 1) are fer netic and piezoelectric (Abstr. 11825 of 1960). They are orhombic with a = 8.75 ± 0.03, b = 9.40 ± 0.03, 5.07 ± 0.03 A; probable space group C_{2v}^{9}—Pc 2,n; bs.) = 5.2 g/cm^3, d (calc.) = 5.53 g/cm^3; 8 molecules per unit . A full investigation of the structure is in progress.

J.Iball

5093 A TEST OF THE APPLICATION OF ANOMALOUS DISPERSION OF X-RAYS TO THE STUDY OF THE TRIBUTION OF IONS IN COMPOUNDS WITH THE SPINEL UCTURE.

J.Goffin, N.Baffier and M.Huber.

.. Acad. Sci. (France), Vol. 252, No. 18, 2744-6 (May 3, 1961).
rench.

Measurements of the ratio of intensities of 400 and 422 ections were made with a series of wavelengths on spinels a_2O_4, where M is Mn, Ni, Co or Zn.

A.R.Stokes

15094 INFLUENCE OF MANGANESE AND OXYGEN CONTENT ON TETRAGONAL DEFORMATION OF PPER FERRITE.

A.Bergstein and L.Červinka.

ech. J. Phys., Vol. 11, No. 8, 584-94 (1961).

Pure copper ferrite and solid solutions of ~ 0.9 parts of copper rite $CuFe_2O_{4-\gamma(1)}$ and ~ 0.1 part of hausmannite $Mn_3O_{4+\gamma(2)}$ were ted in air or in oxygen at various temperatures and either led slowly or quenched. All the samples with cubic spinel ucture contained less oxygen than required for the ideal spinel mula $Me^{2+}Me_2^{3+}O_4^{2-}$. The additional of hausmannite promotes the mation and/or stabilization of the cubic structure. The lower heating temperature, the higher the oxygen deficiency essary for the preparation of cubic samples.

15095 THE CRYSTAL STRUCTURES OF $KMnF_3$, $KFeF_3$, $KCoF_3$, $KNiF_3$ AND $KCuF_3$ ABOVE AND BELOW THEIR EL TEMPERATURES.

A.Okazaki and Y.Suemune.

Phys. Soc. Japan, Vol. 16, No. 4, 671-5 (April, 1961).

The crystal structures of the antiferromagnets $KMnF_3$, $KFeF_3$, oF_3, $KNiF_3$ and $KCuF_3$ were determined above and below their el temperatures (T_N) by X-ray diffraction using single crystals. room temperature (above T_N) the structures of these compounds e of the ideal perovskite type (cubic) except for that of $KCuF_3$ ich crystalizes as a tetragonal modification (a > c) of the perovite type. At 78°K (below T_N) the lattice symmetries of $KMnF_3$, eF_3 and $KCoF_3$ are monoclinic, rhombohedral ($a < 90°$) and tetranal (a > c), respectively, while $KNiF_3$ and $KCuF_3$ retain their own mmetries at room temperature. The lattice constants were deterned between these temperatures and their changes near the tranion temperature were closely followed. This temperature region s extended up to 670°K for $KCuF_3$.

15096 TETRAGERMANATES OF STRONTIUM, LEAD, AND BARIUM OF FORMULA TYPE AB_4O_9.

R.Robbins and E.M.Levin.

Res. Nat. Bur. Stand. (USA), Vol. 65A, No. 2, 127-31 farch-April, 1961).

Three new tetragermanates, $SrGe_4O_9$, $PbGe_4O_9$, and $BaGe_4O_9$, formula type AB_4O_9 were found. $BaTiGe_3O_9$, the germanium alog of the mineral silicate benitoite ($BaTiSi_3O_9$) was prepared r study and comparison. Indexed X-ray powder diffraction tterns of the tetragermanates and of $BaTiGe_3O_9$ and $BaTiSi_3O_9$ ow: (1) the tetragermanates are apparently isostructural;) the unit cell of $BaTiGe_3O_9$ at room temperature is related to at of the tetragermanates by a doubling of the c-axis of the tter; (3) the tetragermanates and the metastable (room mperature) form of $BaTiGe_3O_9$ are apparently structurally similar , but not isostructural with benitoite; (4) within its temperature ability range, $BaTiGe_3O_9$ appears to be isostructural with $aTiSi_3O_9$. Density, melting point, and partial optical data for the tragermanates were obtained.

15097 PEROVSKITE-TYPE COMPOUNDS BASED ON PLUTONIUM.

E.Russell, J.D.L.Harrison and N.H.Brett.

nuclear Materials (Internat.), Vol. 2, No. 4, 310-20 (Dec., 1960).

The preparation of perovskite-type compounds containing ivalent or quadrivalent plutonium has been attempted. Crystallo-raphic data for the compounds $PuAlO_3$, $PuVO_3$, $PuCrO_3$ and $BaPuO_3$ re reported.

15098 THE STRUCTURE OF ALLEVARDITE.

Yu.M.Korolev.

ristallografiya (USSR), Vol. 5, No. 6, 891-5 (Nov.-Dec., 1960).
Russian.

The unit cell of allevardite, $Na_{0.17}Ca_{0.21}K_{0.03}(H_3O)_{1.00}(Al_4)[Al_{1.45}Si_{6.55}O_{20}](OH)_4 \cdot 3.24H_2O$, consists of two open layers resembling those in mica. A one-dimensional Fourier synthesis was used to determine the Z coordinates of the layers; it is found that $(H_3O)^+$ ions are responsible for binding the layers together. The small repeat of Z is caused by variations in the amount of the cations that bind the layers together (Potassium, calcium, hydroxonium). [English translation in: Soviet Physics – Crystallography (USA), Vol. 5, No. 6, 848-52 (May-June, 1961)].

15099 SYNTHESIS OF $BiFeO_3$ AND DETERMINATION OF THE UNIT CELL.

V.S.Filip'ev, N.P.Smolyaninov, E.G.Fesenko and I.N.Belyaev.
Kristallografiya (USSR), Vol. 5, No. 6, 958-9 (Nov.-Dec., 1960).
In Russian.

[English translation in: Soviet Physics—Crystallography (USA). Vol. 5, No. 6, 913-14 (May-June, 1961)].

MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF HEXAGONAL BARIUM MONO-FERRITE, $BaO.Fe_2O_3$.

See Abstr. 14735

STRUCTURE OF SOME Ca—Fe—O COMPOUNDS.

See Abstr. 14743

15100 COMPOUNDS WITH THE HEXAGONAL BARIUM TITANATE STRUCTURE.

J.G.Dickson, L.Katz and R.Ward.
J. Amer. Chem. Soc., Vol. 83, No. 14, 3026-9 (July 20, 1961).

A number of compounds of the type $Ba(M, Ti)O_3$ where M = Ti^{3+}, V, Cr, Mn, Fe, Co, Ru, Rh, Ir, Pt were prepared and are shown to have the hexagonal barium titanate structure. The phases probably have a composition close to $Ba(M_{1/3}Ti_{2/3})O_3$ and are in some cases oxygen-deficient. Evidence from X-ray and magnetic studies indicates that the M cation is concentrated mainly in the four-fold position in the hexagonal cell and is bonded directly to a titanium ion in the neighbouring position. The adoption of the structure appears to be dependent upon the formation of a metal—metal bond through overlapping d-orbitals.

15101 CRYSTAL STRUCTURE OF ORTHITE.

I.M.Rumanova and T.V.Nikolaeva.

Kristallografiya (USSR), Vol. 4, No. 6, 829-35 (Nov.-Dec., 1959).
In Russian.

Orthite $(Ca,Ce,La,Na,Mn^{2+})_2(Al,Fe,Mg)_3Si_3O_{12}(OH,O)$ possesses the structural motif of epidote $Ca_2(Al,Fe^{3+})Al_2O(OH)[Si_2O_7][SiO_4]$, but has the interesting peculiarity that, of the two crystallographically independent atoms of Ca in the structure of epidote, only one (that in the "looser" oxygen polyhedron) is isomorphously replaced by a Ce atom in orthite. At the same time, part of the Fe^{3+} cations are replaced by Fe^{2+} cations. The detailed formula for orthite is thus $CaCe(Fe^{2+},Fe^{3+})Al_2O(OH,O)[Si_2O_7][SiO_4]$. The absence of cleavage in orthite is well explained by the regular replacement of part of the Ca by Ce, and in this respect it differs markedly from epidote, in which there is perfect cleavage along (001) and imperfect cleavage along (100). [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 789-95 (June, 1960)].

15102 BAOTITE — A MINERAL WITH $[Si_4O_{12}]$ METASILICATE RINGS.

V.I.Simonov.

Kristallografiya (USSR), Vol. 5, No. 4, 544-6 (July-Aug., 1960).
In Russian.

The crystal structure of baotite (space group $I4_1/a$, dimensions of the unit cell: a = 19.68, c = 5.88 A) was established by the method of minimization of Patterson projections. The final atomic coordinates resulted from several computing of the signs of *hkl* alternating with Fourier syntheses. Baotite is an example of a ring silicate with the tetragonal radical $[Si_4O_{12}]$. The detailed formula of baotite is $Ba_4(Ti,Nb)_8ClO_{16}[Si_4O_{12}]$. The ring radicals $[Si_4O_{12}]$ are on the 4-fold inversion axes, and (Ti,Nb)-octahedra are around 4-fold screw axes in columns analogous to those in the structure of rutile. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 523-5 (Jan.-Feb., 1961)].

15103 CRYSTAL STRUCTURE OF NARSARSUKITE.

Yu.A.Pyatenko and Z.V.Pudovkina.

Kristallografiya (USSR), Vol. 5, No. 4, 563-73 (July-Aug., 1960).
In Russian.

The complete structure investigation of narsarsukite, $Na_2(Ti,Fe)(O,OH)-[Si_4O_{10}]$, was undertaken. It was found to be tetragonal, the unit cell dimensions being a = 10.72, c = 7.99 A. The atomic arrangement was determined by Patterson and Fourier syntheses. Narsarsukite represents a new structure type with $[Si_4O_{10}]_\infty$ chains stretching along c. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 540-8 (Jan.-Feb., 1961)].

15104
ELECTRON-DIFFRACTION REFINEMENT OF THE STRUCTURE OF MUSCOVITE.

B.B.Zvyagin and K.S.Mishchenko.
Kristallografiya (USSR), Vol. 5, No. 4, 600-4 (July-Aug., 1960).
In Russian.

On the basis of electron-diffraction data from texture patterns a refinement of the structure was carried out using Fourier syntheses. It was established that Al may replace Si only in the half of the tetrahedra which are joined to the oxygens next to the glide planes of the octahedral layer. The substitution of Al in a tetrahedron results mainly in a change in the oxygen position in the reflection plane of the tetrahedral layer, and, as a result, in a shift of K, and this leads to a slight increase in β over the theoretical value. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 575-9 (Jan.-Feb., 1961)].

15105
THE CRYSTAL STRUCTURE OF ANAPAITE.

I.M.Rumanova and M.N.Znamenskaya.
Kristallografiya (USSR), Vol. 5, No. 5, 681-8 (Sept.-Oct., 1960).
In Russian.

The structure of anapaite $Ca_2Fe(PO_4)_2.4H_2O$ was completely determined from ordinary and modulated projections of the Patterson function on to the xy-plane. The structure is basically composed of layers of oxygenous Fe octahedra and Ca heptavertica which are parallel to (010) and joined by PO_4 tetrahedra. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 650-8 (March-April, 1961)].

15106
CRYSTAL STRUCTURE OF PARACELSIAN.

V.V.Bakakin and N.V.Belov.
Kristallografiya (USSR), Vol. 5, No. 6, 864-8 (Nov.-Dec., 1960).
In Russian.

Paracelsian $BaAl_2Si_2O_8$ is very similar not only to danburite $CaB_2Si_2O_8$, as has been pointed out, but also to hurlbutite $CaBe_2P_2O_8$.

	a, A	b, A	c, A	β	a : b : c	Space group
Danburite	8.01	9.75	7.71	$\beta = 90^0$;	0.915 : 1 : 0.881;	$D_{2h}^{16} = Pnam$
Hurlbutite	8.29	8.80	7.81	$\beta \cong 90^0$;	0.942 : 1 : 0.887;	$C_{2h}^{5} = P2_1/a$
Paracelsian	9.08	9.58	8.58	$\beta \cong 90^0$;	0.947 : 1 : 0.895;	$C_{2h}^{5} = P2_1/a$

The hurlbutite—paracelsian pair has a" : a' ≅ b" : c" : c' ≅ 1.1. [English translation in: Soviet Physics - Crystallography (USA), Vol. 5, No. 6, 829-9 (May-June, 1961)].

15107
THE STRUCTURE OF NATURAL FERGUSONITE, AND OF A POLYMORPHIC MODIFICATION.

A.I.Komkov.
Kristallografiya (USSR), Vol. 4, No. 6, 836-41 (Nov.-Dec., 1959).
In Russian.

Structure studies are reported for fergusonite from the Central Urals, and for a polymorphic form produced by heating the mineral to over 1000° C and allowing it to cool to room temperature. [English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 796-800 (June, 1960)].

15108
ORDER AND DISORDER.
II. THEORY OF DIFFRACTION EFFECTS IN THE INTERMEDIATE PLAGIOCLASE FELSPARS.

H.D.Megaw.
Proc. Roy. Soc. A (GB), Vol. 259, 159-83 (Dec. 6, 1960).

For Pt I, see Abstr. 976 of 1961. X-ray diffraction effects in the intermediate plagioclase felspars $An_{1-x}Ab_x$, where $x \cong \frac{2}{9}$ to $\frac{7}{9}$, are explained quantitatively, as regards breadths and intensities as well as positions of the maxima, by an ideal structure subject to stacking faults. This is deduced directly, by classical diffraction theory, from the published evidence about the diffraction effects, without making any assumption about detailed atomic arrangements. The unit cell of the ideal plagioclase structure has edges a_0, $9b_0$, $2c_0$, where $a_0 = a_{Ab}$, $b_0 = \frac{1}{2}(a_{Ab} + b_{Ab})$, $c_0 = \frac{3}{2}a_{Ab} + \frac{1}{2}b_{Ab} + c_{Ab}$. Sixteen of the eighteen subcells resemble closely one or other of the four different subcells of anorthite, and are juxtaposed so as to build up extensive anorthite-like slabs within the structure; the remaining two subcells form transitional sheets parallel to $(010)_0$. Regularly distributed stacking faults on $(100)_0$, with slip vector $-2b_0$, are responsible for the most conspicuous variation with composition of the positions of "e" maxima ("split-b reflections") and "f" maxima ("satellite spots"); stacking faults on $(010)_0$ and $(001)_0$ account for other features.

15109
ORDER AND DISORDER.
III. THE STRUCTURE OF THE INTERMEDIATE PLAGIOCLASE FELSPARS.

H.D.Megaw.
Proc. Roy. Soc. A (GB), Vol. 259, 184-202 (Dec. 6, 1960).

The lattice and fault system deduced in Pt II are consider
relation to the atomic structure, the known structure of anort
serving as a starting point. Small amounts of Si above the 1 :
ratio are distributed randomly among half the Al_2 sites, causi
faults with slip vector c_0 (where the subscript 0 indicates axe
fined in Pt II). At $x = \frac{2}{9}$ the new structure is formed, with its
cess Si concentrated in all B sites in two bridging subcells, t
maining 16 subcells having the (Si, Al) alternation of anorthite
With changing composition, Si continues to enter the same set
sites, now causing faults on $(100)_0$ with slip vector $-2b_0$ as we
those with slip vector c_0, taken as on $(010)_0$, until this new set
sites is filled at $x = \frac{6}{9}$. Then a new kind of fault on (001) appe
probably occuring randomly with slip vector b_0, and causing a
gressive break-up of the (Si, Al) sequence of anorthite, hither
served except in the bridging subcells. This fault accounts fo
diffuseness and eventual disappearance of "e" maxima. Ther
some evidence of (Ca, Na) segregation on different A sites be
$x = \frac{2}{9}$ and $\frac{4}{9}$. All observed diffraction effects in the low-tempe
plagioclases are accounted for quantitatively, and the changes
duced by heat treatment qualitatively. A qualitative discussio
the nature of the process is included, with emphasis on the dif
ence between the effect of misfits of a puckering nature and m
due to atomic substitution. The implications of this type of ap
for dealing with other materials showing subsidiary reflection
considered.

MAGNETIC COMPOUNDS OF HEXAVALENT RHENIUM W
THE PEROVSKITE-TYPE STRUCTURE. See Abstr. 14694

15110
SPACE GROUPS OF CRYSTALS OF α-, β- AND γ-PICOLINE AT −180° C.

S.G.Biswas.
Indian J. Phys., Vol. 35, No. 5, 261-8 (May, 1961).

The dimensions of the unit cell, number of molecules per
cell and the space groups of crystals of α-, β- and γ-picoline
−180° C were determined by studying the Debye—Scherrer patt
of the crystals. All the crystals are found to have the monocl
lattice. The space-group assigned to the α-picoline crystal is
with $a = 9.97$, $b = 10.91$, $c = 10.90$ A, $\beta = 111^\circ 54'$, that of β-pic
is $P2_1/m$ with $a = 6.95$, $b = 11.87$, $c = 7.05$ A, $\beta = 94^\circ 12'$ and th
the γ-picoline crystal is $P2_1/c$ with $a = 7.21$, $b = 7.69$, $c = 10.2$
$\beta = 110^0 42'$.

15111
THE CRYSTAL STRUCTURE OF CHLORANIL AN
BROMANIL.

I.Ueda.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1185-94 (June, 1961).

The crystal structure was determined by an X-ray diffrac
technique based on two-dimensional Fourier analysis. Chlora
and bromanil are isomorphous. The cell constants are: $a_0 = $
$b_0 = 5.83_7$, $c_0 = 8.76_3$ A, $\beta = 72.6^0$ for chloranil and $a_0 = 8.62_4$,
$b_0 = 6.17_3$, $c_0 = 9.02_7$ A, $\beta = 74.2^0$ for bromanil. There are two
molecules in the unit cell and the space group is $P\,2_1/a\,(C_{2h}^5)$.
crystal consists of two layers of substituted halogen atoms w
are parallel to the (001) plane, and the skeletons consisting of
oxygen and carbon atoms lie between these two layers. The ju
position of molecules is such that the dipole interactions betw
C = O bonds stabilize the structure. There is definite localiza
of the double bonds in the benzene ring. In the molecule the
adjacent halogen and oxygen atoms protrude respectively up a
down from the plane of the benzene ring making a puckered for
The thermal motions of the molecules in this crystal were ana
from the anisotropic thermal parameters of chlorine and oxyg
atoms. A theoretical analysis shows that the puckered form i
stable, as a molecule, than the planar form. A clear correspo
is found between this fact and the anisotropic thermal motions
and O atoms.

15112
A DIRECT DETERMINATION OF THE CRYSTAL STRUCTURE OF ETHYLENEDIAMMONIUM SULP

K.Sakurai.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1205-13 (June, 1961).

The Harker—Kasper inequality method was applied succe
to determine most of the signs of structure factors of ethylene
diammonium sulphate. Starting from these signs, the final Fo
projections on (001) and (100) were obtained. The dimensions
the unit cell containing eight formula units are $a = 8.47 \pm 0.02$
$c = 18.03 \pm 0.04$ A, and the space group is $D_4^4 - C4_122_1$ or D_4^8 –
The ethylenediammonium group is of gauche type with an azim

le of 75.7°. The hydrogen bond distances found in this crystal 2.80 A, 2.81 A, and 2.82 A. The existence of only one kind of two ror-image configuration of the ethylenediammonium ion in one he enantiomorphous forms of this crystal may be an important se of the strong optical rotatory power of the crystal.

15113 SPACE GROUPS OF CRYSTALS OF ORTHO, META AND PARAXYLENE AT -180°C.

S.G.Biswas.

ian J. Phys., Vol. 34, No. 6, 263-71 (June, 1960).

The Debye–Scherrer patterns of frozen o-xylene, m-xylene l p-xylene at –180°C were photographed and analysed. The ılysis gives unit cell dimensions which explain all the reflections. e densities were 1.032, 1.030 and 1.006 g cm^{-3} respectively for ortho, meta and para compounds. The crystals of o-xylene ong to the orthorhombic system with a = 8.77, b = 10.20 and 14.55 A; the number of molecules per unit cell is 8 and the ace group Pmmm. The crystals of m-xylene also belong to the horhombic system, with a = 7.77, b = 8.45, c = 10.47 A; the mber of molecules per unit cell is 4 and the space group P2$_1$2$_1$2. e crystals of p-xylene belong to the monoclinic system with 7.56, b = 8.45, c = 11.11 A, β = 98° 57'; the number of molecules r unit cell is 4 and the space group P2$_1$/m.

ALLOYS . METALLURGY

15114 CONSTRUCTION OF POLE FIGURES OF "TEXTURED" METALS BY AN ELECTRON DIFFRACTION METHOD.

.I.Sozin.

z. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 892-6 (June, 60). In Russian.

The pole figures of a plastically deformed metal are constructed om electron diffraction measurements in a manner which is mpler and quicker than that based on the X-ray diffraction technique. The {111}, {001}, and {011} pole figures of cold-rolled Cu and , obtained by the new method, were essentially identical with ose constructured from X-ray diffraction measurements.

M.H.Sloboda

CONDUCTION ELECTRONS IN PSEUDONICKEL ALLOYS OM HALL DATA. See Abstr. 14363

15115 DETERMINATION OF THE NATURE OF THE GRAIN BOUNDARIES FROM THE X-RAY SCATTERING ATTERN.

V.I.Arkharov, B.S.Borisov and S.D.Vangengeim.

z. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 367-74 ept., 1960). In Russian.

The background intensity of X-ray diffraction patterns, obtain- l on massive Ag and Cu, was measured and found to be greater ıan that relating to powder specimens with the same grain size. he experimentally determined difference was correlated with the ılculated intensity of background of X-rays scattered by the espective metals with a perfect crystal lattice, and from this the lative quantity of "amorphous" metal, constituting the rain boundary of polycrystalline specimens, was determined. his, in conjunction with the known grain size of the specimens, ıade it possible to calculate the width of the grain boundaries hich varied from ~ 80 A for metal of 99.999% purity to 500 A for 99.99% pure material. These results agreed well ith data obtained by other, indirect methods.

M.H.Sloboda

15116 MECHANICAL STABILITY OF LARGE-ANGLE DISLOCATION GRAIN BOUNDARIES.

.N.Orlov and I.A.Shvarte.

iz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 492-4 ept., 1960). In Russian.

Following the work of Hollander (Abstr. 6039 of 1960), who tudied a generalized dislocation model of a grain boundary omprising n two-dimensional parallel arrays of dislocations, ormed by equi-distant and parallel edge dislocations, the present uthors derive equations for the equilibrium distance between the islocation arrays in a model with an arbitrary n. They obtain a olution of these equations for n = 5, compare the grain boundary nergies for a given degree of misorientation and n = 1, 3, or 5, nd discuss grain boundaries consisting of dislocation arrays, haracterized by different dislocation density.

M.H.Sloboda

15117 DETERMINATION OF THE ORIENTATION OF THE DIFFUSIONAL SUBMICROPORES IN α-BRASS BY THE SMALL ANGLE X-RAY SCATTERING METHOD.

V.L.Kalikhman and Ya.S.Umanskii.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 331-5 (Feb., 1961). In Russian.

Experiments are described on the formation of pores in single crystal plates of α-brass (70% Cu, 30% Zn) on removal of zinc by heating. The technique of small-angle scattering is described and applied to find the variation with orientation of the size of pores in the (100) plane. It is concluded that the nuclei of the pores are orientated in the (110) plane. See also Abstr. 2550 of 1961. [English translation in: Soviet Physics - Solid State (USA), Vol. 3, No. 2, 238-40 (Aug,, 1961)].

A.Tybulewicz

15118 AN X-RAY STUDY OF SILVER–CADMIUM ALLOYS.

M.A.Quader.

Indian J. Phys., Vol. 34, No. 11, 506-15 (Nov., 1960).

An X-ray investigation of the Ag–Cd system of alloys was carried out to determine the phase boundaries at temperatures below 300° C with particular attention to the β-field. The presence of the β' phase, which occurs in the β-field at temperatures below 228° C, was confirmed. The lattice parameter and structure of the α, β' and ζ phases were determined. An approximate boundary of the β' phase was obtained. The boundaries of the other phases agree with those of Owen et al. (1939). The results are discussed in the light of the Hume-Rothery rule and the zone-theory.

15119 EFFECTS OF THE SPECIAL HEAT-TREATMENT ON PERMALLOYS.

S.Tomita.

J. Phys. Soc. Japan, Vol. 16, No. 3, 393-6 (March, 1961).

The magnetic properties and the electrical resistance of mumetal and 50-permalloy were measured after low temperature heat-treatment ranging from 200° to 600° C. It was observed that the maximum permeability of mumetal is remarkably increased by this heat-treatment. These results can not be explained simply by the existing theories proposed by Néel et al. (Abstr. 7548 of 1954). From the comparison between experimental results obtained in binary permalloy and polynary permalloy and the analysis of the relation between the maximum permeability and the electrical resistance, the idea of inhomogeneous internal structure is introduced to explain the change of μ_0, μ_m of permalloys by this low temperature heat-treatment.

15120 AN ELECTRON DIFFRACTION STUDY ON Cu–Sn ALLOYS.

T.Mitsuishi.

J. Phys. Soc. Japan, Vol. 16, No. 3, 453-5 (March, 1961).

Intermetallic compounds produced by the interdiffusion of Cu and Sn were examined by electron diffraction. In addition to the known phases, a new phase of structure A4 type is found.

15121 X-RAY SMALL ANGLE SCATTERING FROM PRECIPITATED PLATELETS IN Al–Ag ALLOY.

Y.Yoneda and K.Nishioka.

J. Phys. Soc. Japan, Vol. 16, No. 3, 578-9 (March, 1961).

The distribution of platelet thickness of γ' phase in an Al–20% Ag alloy was obtained.

H.Mykura

15122 MORE ON X-RAY DIAGRAMS WITH SATELLITES.

Yu.A.Bagaryatskii and Yu.D.Tyapkin.

Kristallografiya (USSR), Vol. 5, No. 4, 535-9 (July-Aug., 1960). In Russian.

Two hypotheses concerning the nature of satellites visible on the X-ray diagrams of dissociated solid solutions are considered. On the basis of a comparison of diagrams due to soft (K_α Cu–Fe) or hard (K_α Mo) radiations, it is concluded that one hypothesis (of independent complexes) is valid for the early stage of dissociation, and a second (of modulated structure) is valid for later stages. On the hard radiation diagram, satellites are also observed near the interferences with low indexes hk*l*. [English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 4, 513-18 (Jan.-Feb., 1961)].

15123 ATOMIC STRUCTURES OF SOME COMPOUNDS OF BISMUTH AND ANTIMONY.

N.N.Zhuravlev, G.S.Zhdanov and R.N.Kuz'min.

Kristallografiya (USSR), Vol. 5, No. 4, 553-62 (July-Aug., 1960). In Russian.

The binary alloys Bi–Rb, Bi–Cs, Bi–Pd, Bi–Pt, Sb–Rh, Sb–Ir were investigated using X-rays and microscope data. The structures of a number of compounds of these systems, as well as the structures of Sb_2M (M = Ru, Os) were determined. The existence was ascertained of several isomorphous series: compounds of bismuth with alkaline elements and compounds of antimony with elements of Group VIII. For bismuth compounds, the correlation between the superconducting phase transition temperature and the minimum interatomic distances Bi—Bi was examined. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 532-9 (Jan.-Feb., 1961)].

15124 TERNARY SYSTEM Th—Ce—Al.

J.H.N. van Vucht.

Philips Res. Rep. (Netherlands), Vol. 16, No. 1, 1-40 (Feb., 1961).

A report is given of investigations into the crystal structure of various phases of the ternary system Th—Ce—Al and the results obtained. Included is a review of data, in part published previously, about the binary systems Th—Al, Ce—Al and Th—Ce. Furthermore some data about the phase transformation of the element cerium are communicated. No ternary compounds were found. The structure of a nonevaporating getter Ceto, because of which the investigations were started, was determined.

15125 REFLEXION COEFFICIENT OF A Cu—Sn ALLOY OBTAINED BY SIMULTANEOUS EVAPORATION OF ITS CONSTITUENTS.

L.Grigorescu and M.Nachman.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 4, 673-80 (1959). In Roumanian.

Cu—Sn alloy films, 1000 A thick, were deposited on glass plates by simultaneous evaporation in vacuum. The reflexion coefficient in normal incidence of these films was studied and the resulting minima were proved to correspond to the intermetallic compounds of the Cu--Sn system.

15126 ELECTRON DIFFRACTION STUDIES ON A Cu—Sn ALLOY OBTAINED BY SIMULTANEOUS EVAPORATION OF ITS CONSTITUENTS.

L.Grigorescu and I.Teodorescu.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 10, 681-8 (1959). In Roumainia.

Thin Cu—Sn alloy films (300 A) obtained on a glass plate by simultaneous evaporation in vacuum, were studied by electron diffraction. All the phases of Cu—Sn system were observed, except the ϵ-phase (Cu_3Sn). The latter was formed either by thermal treatment or by deposition of the alloy on a hot substratum.

15127 CHANGE IN THE FINE CRYSTALLINE STRUCTURE ON THE AGING OF CERTAIN HIGH-TEMPERATURE ALLOYS [NIMONIC TYPE].

H.V.Kurdyumov, I.A.Bil'dzyukevy̆ch, L.G.Khandross and V.G.Chorny̆i.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 4, 495-505 (1958). In Ukrainian.

The changes in the fine crystalline structure, the dimensions of the coherent X-ray scattering regions and the constant crystal lattice were studied. The state of the intermetallic phase resulting from dissociation was also studied. It was established that the rise in hardness with aging of the alloys investigated is due to the appearance of a large number of high-dispersion α'-phase particles, apparently coherent with the matrix, but not leading to the formation of microstress.

15128 EFFECT OF SHORT-RANGE ORDER ON THE RESIDUAL RESISTANCE OF NICKEL ALLOYS.

I.Ya.Dekhtyar, S.H.Ly̆tovchenko and D.A.Ursul.

Ukrayin.fiz. Zh. (USSR), Vol. 3, No. 4, 506-14 (1958). In Ukrainian.

The dependence was studied of the residual resistance on the degree of short-range order of binary alloys with a nickel base (Ni_3Mn; Ni—Au with 6 atomic per cent of Au; Ni—Mo with 16 atomic per cent of Mo). A decrease in the degree of short-range order in the ordering alloy Ni_3Mn leads to a gradual fall in the residual resistance and is accompanied by an increase in the lattice parameter. This leads to a decrease in the degree of filling of d- and s-shells in the alloy atoms. Thus, the number of conductivity electrons rises, while the electrical resistance falls. Proceeding from X-ray data on the nature of the short-range order in dissolving alloys of the Ni—Au system, and the data obtained during the present study, the assumption may be made that the residual resistance rises in the alloy with a decrease in the degree of short-range order. The rise in the incremental increase of electrical resistance with the rise in the quenching temperature is apparently due not only to the nature of the short-range order, but to the specific character of the interatomic interaction in alloys with transition metals. In the case of the Ni—Mo alloy with the formation of the chemical compound Ni_4Mo, the existence was established of anomalies in the change of residual resistance of the α-solid solution in the te
ture ranges 860—930°C and 1000—1060°C. It is assumed that
variability of the residual resistance in these temperature ra
connected with the variability of the short-range order at the
temperatures.

15129 CERTAIN ANOMALIES IN THE PROPERTIES OF FERRO—ALUMINIUM ALLOYS AND THEIR NAT

P.P.Kuz'menko and P.V.Petrenko.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 4, 497-503 (1959). In Uk

Results are presented of an experimental investigation of
dependence of the lattice parameter on the concentration and
temperature, and on the oxidizability of these alloys with 16,
25, 30, 35, 40 and 50 at. % of Al at 1200°C in air. It is shown
the anomalous dependence of the lattice parameter on the con
tration is preserved throughout the investigated temperature
(up to 1000°C). There is, however, a considerable deformati
of the curve of dependence of the parameter on concentration
change of temperature. The alloys may be divided into group
concentration with respect to the tendency to oxidize at 1200°
The first embraces the interval from 16 to 20% Al, and the se
from 20 to 50% Al. The oxidizability of the second group depe
slightly on the concentration and has a value of the order of
2 g m^{-2} hr^{-1} with a 30-40 hour exposure in air. On passing f
20% to 16% the oxidizability increases by a factor of 200. It
also shown that with deformation alloys with 35, 40, 50% A
become ferromagnetic. Subsequent annealing at 700°C for two
hours leads to the disappearance of ferromagnetism. An expla
of the nature of the anomalous properties of the alloys is give
from the standpoint of superposing ionic coupling due to redist
tion of valence electrons among the component atoms in the al

INVESTIGATION OF THE EFFECT OF SHORT-RANGE O ON THE ELECTRICAL RESISTANCE OF CERTAIN BINARY A

See Abstr. 14354

15130 A TRANSITION PHASE IN THE AGEING OF ALUMINIUM—ZINC ALLOYS.

R.D.Garwood, A.L.Davies and G.L.Richards.

J. Inst. Metals (GB), Vol. 88, Pt 8, 375-8 (April, 1960).

A face-centred cubic transition phase has been detected i
Debye—Scherrer X-ray diffraction photographs of an aluminiu
25% zinc alloy during isothermal transformation at 200°C. Th
intermediate precipitate was granular in form and contained
approximately 80% zinc. A plate-like precipitate with the hexa
structure of zinc appeared after long ageing.

15131 THE FORMS OF THE RELATIVE PARTIAL MOLA THERMODYNAMIC FUNCTIONS IN SOLID BINARY TERNARY SYSTEMS.

F.H.M.Videira and B.B.Argent.

J. Inst. Metals (GB), Vol. 88, Pt 8, 379-80 (April, 1960).

Changes in the functions on crossing phase boundaries are derived, and it is suggested that the analysis may be f value in checking doubtful experimental data.

15132 THE TRANSFORMATIONS OF THE ALLOY Mn Sn

P.Taglang and Fournier.

J. Phys. Radium (France), Vol. 22, No. 5, 295-7 (May, 1961). In French.

The existence of two successive transformations in the He
alloy, $MnSnCu_2$, was ascertained by studying its real expansion
the variation of its electrical resistance, and by X-ray investig
tions. The ferromagnetic properties of this alloy are due to th
steady state between the two transformations.

15133 FRESH STRUCTURAL DATA ON THE DECOMPOS OF SUPERSATURATED SOLID SOLUTIONS OF TITANIUM IN NICKEL AND NICHROME.

Yu.A.Bagaryatskii and Yu.D.Tyapkin.

Kristallografiya (USSR), Vol. 5, No. 6, 882-90 (Nov.-Dec., 196
In Russian.

A detailed study was made of monocrystals of nickel—tita
and nickel—chromium—titanium alloys with special reference
transition from the first stage of decomposition (titanium unev
distributed in the originally cubic crystal) to the second stage
(inclusions of a hexagonal phase produced). [English translati
Soviet Physics—Crystallography (USA), Vol. 5, No. 6, 841-7
(May-June, 1961)].

15134 THE PHASE DIAGRAM OF THE GALLIUM—TELLURIUM SYSTEM.

Newman, J.C.Brice and H.C.Wright.
ips Res. Rep. (Netherlands), Vol. 16, No. 1, 41-50 (Feb., 1961).

The phase diagram of the gallium—tellurium system has been stigated by differential thermal analysis and direct observation ielting points under controlled tellurium pressures. The lts of these investigations, which are confirmed by X-ray ysis, show that besides the two compounds already known Te and Ga_2Te_3), there exist two other compounds Ga_3Te_2 and e$_3$. These two compounds, however, are not stable at room perature. A hexagonal unit cell for $GaTe_3$ with a = 6.43 A and 14.20 A is reported. The melting points of GaTe and Ga_2Te_2 835 ± 2°C at 6×10^{-2} mm Hg Te-pressure and 792 ± 2°C at m Hg, respectively. Upper decomposition limits for Ga_3Te_2 $GaTe_3$ are 753 ± 2°C and 429 ± 2°C.

5135 LOW-TEMPERATURE PHASE TRANSITION IN ALPHA URANIUM. E.S.Fisher and H.J.McSkimin.

s. Rev. (USA), Vol. 124, No. 1, 67-70 (Oct. 1, 1961).

A phase transition in α-uranium at 42° ± 1°K is indicated by asurements of the single-crystal elastic moduli using ultrasonic se techniques. The indicated transition coincides closely to malies noted in the thermal expansion, Hall coefficient, electri- resistivity, and thermoelectric power. An examination of the rature specific heat data shows that the transition is associated h an inflection point in the entropy versus temperature curve. the basis of the elasticity and available lattice parameter data s postulated that the temperature dependence of the γ positional ameter becomes relatively large in this range and the phase tability is a result of a change in the nature of certain inter-

15136 THE EFFECT OF PLASTIC DEFORMATION ON CRYSTAL STRUCTURE CHANGES IN THE AGING OF E ALLOY Cu—Ti. Ye.H.Nesterenko and K.V.Chuistov.

rayin. fiz. Zh. (USSR), Vol. 3, No. 3, 427-8 (1958). In Ukrainian.

15137 THE RESISTANCE TO DEFORMATION OF METALS IN THE CASE OF PHASE TRANSFORMATION.

N.Hridnyev,V.M.Minakov and V.I.Trefilov.
rayin. fiz. Zh. (USSR), Vol. 4, No. 4, 526-7 (1959). In Ukrainian.

Fe—Ni and Fe—Cu alloys were investigated in the α → γ nsition.

15138 TEMPER AGEING OF RESIDUAL AUSTENITE IN HIGH-SPEED STEEL. P.M.Yushkevȳch.

rayin.fiz. Zh. (USSR), Vol. 4, No. 6, 760-8 (1959). In Ukrainian.

The lattice parameter of residual austenite decreases with an rease in the martensite content of the steel, but increases ring the first stages of tempering of such a compressed austenite. the subsequent stages of tempering, the parameter of the sidual austenite diminishes owing to depletion mainly in carbon, t partially in alloying components as well. During tempering, sidual austenite is continuously strengthened due to increase in stortions of types II and III. These distortions arise during rbide precipitation. The temperature at the beginning of artensitic transformation during multiple tempering depends on e static distortions of the crystalline lattice.

15139 DIFFUSE SCATTERING OF X-RAYS BY Cu—Al ALLOYS. A.S.Kagan, V.A.Somenkov and Ya.S.Umanskii.

istallografiya (USSR), Vol. 5, No. 4, 540-3 (July-Aug., 1960). Russian.

The presence of short-range order in the Cu—Al alloy containing .6% Al was demonstrated using the diffuse scattering of X-rays. e change of short-range order after quenching, annealing, work-rdening and subsequent low temperature tempering was investigat- . The absence of a marked atomic-size effect was noted. nglish translation in: Soviet Physics—Crystallography (USA), l. 5, No. 4, 519-22 (Jan.-Feb., 1961)].

15140 ORDER — DISORDER TRANSITIONS IN A BINARY ISING LATTICE. Ye.I.Nesis.

krayin. fiz. Zh. (USSR), Vol. 4, No. 3, 363-71 (1959). In Ukrainian.

A two-way infinite "hole" crystal has no order — disorder ansition. Hence, the cause of the emergence of an order — sorder transition is the unlimited growth of the number of ngagements" between part of the lattice and the remainder.

15141 NATURE OF ATOMIC ORDERING IN Cd—Sn SYSTEM.

Ya.I.Dutchak and N.M.Bondar.
Ukrayin.fiz. Zh. (USSR), Vol. 4, No. 3, 402-3 (1959). In Ukrainian.

THE EFFECT OF LONG-RANGE ORDER ON ENERGY BANDS IN BINARY ALLOYS. See Abstr. 14202

15142 ON THE STRUCTURE OF CAESIUM—BISMUTH PHOTOCATHODES. G.Oertel.

Ann. Phys. (Germany), Vol. 8, No. 3-4, 137-43 (1961). In German.

The structure of compounds of the Cs—Bi system in the form of thin photosensitive films was investigated. The formation of the compounds $CsBi_2$ and Cs_3Bi was inferred from a study of the electrical resistance of the film as Cs reacted with the Bi substrate. Electron diffraction results are quoted for well-annealed Cs_3Bi: it is deduced that in thin films Cs_3Bi crystallizes in cubic crystals of the Cu_3Al type, with the lattice constant a = 9.292 ± 0.013 A. This result is in agreement with previous X-ray determinations. C.H.B.Mee

15143 DISTRIBUTION COEFFICIENT OF ZINC IN GALLIUM ARSENIDE. A.Shibata.

J. Phys. Soc. Japan, Vol. 15, No. 11, 2107 (Nov., 1960).

The distribution coefficient of Zn in doped GaAs was found to be 0.31. J.B.Birks

15144 A NEW PHASE OF AN INTERMETALLIC COMPOUND $Mn_{3.4}Ge$ AND ITS MAGNETISM.

T.Ohoyama, K.Yasukōchi and K.Kanematsu.
J. Phys. Soc. Japan, Vol. 16, No. 2, 352-3 (Feb., 1961).

The high temperature (hexagonal close packed) phase of $Mn_{3.4}Ge$ was found to transform to a face-centred tetragonal structure on annealing at 430°C and quenching. This new phase shows anomalous magnetic properties, the saturation magnetization increasing with temperature to a maximum of 11 c.g.s. e.m.u./g at 700°K. H.Mykura

15145 STUDY ON THE ORDERED ALLOYS OF GOLD—MANGANESE SYSTEM BY ELECTRON DIFFRACTION. III. LATTICE MODULATION IN THE ORDERED Au_3Mn.

D.Watanabe.
J. Phys. Soc. Japan, Vol. 16, No. 3, 469-78 (March, 1961).

For Pt II, see Abstr. 11577 of 1961. Discusses the nature of the lattice modulation which is believed to cause the satellites to flank main reflections in electron diffraction patterns of the ordered Au_3Mn alloy and also in the case of CuAu (II) as well as of Cu_3Pd. Two types of modulation, i.e. a periodic change of lattice spacing and of scattering factor, are considered. It is pointed out that the valence electron may play an important role for the lattice modulation. In order to clarify this problem, a detailed X-ray study is necessary.

INFLUENCE OF SILVER IMPURITIES ON THE ANNEALING KINETICS OF QUENCHED GOLD SPECIMENS. See Abstr. 14256

15146 CHROMIUM CARBIDE PRECIPITATES FORMING ON DISLOCATIONS IN AUSTENITIC NICKEL—CHROME ALLOYS.

G.Henry, J.Plateau, X.Wache, M.Palmier-Gerber and C.Crussard.
C.R. Acad. Sci. (France), Vol. 252, No. 17, 2550-1 (April 24, 1961). In French.

In 77/19 nickel—chrome alloys containing about 0.02% C and hardening additions of Ti and Al precipitates of the type $M_{23}C_6$ were observed. They were formed on dislocations during heat treatments. Precipitates originating in the same grain of an alloy were pseudo single crystals due to the agglomeration of numerous precipitate particles with a fixed orientation with respect to the matrix. Some brief comments are added on the effect of boron on the precipitates. A.E.Kay

15147 CHANGE IN PRIMARY EXTINCTION DURING DECOMPOSITION OF SUPERSATURATED SOLID SOLUTION. III. 4% Al—Cu ALLOY, PRECIPITATION OF PHASE Al_2Cu. K.Toman.

Czech. J. Phys., Vol. 11, No. 1, 34-40 (1961).

The integrated intensity of the matrix reflection (200) was measured during the precipitation of the Θ'', Θ' and Θ phases. The observed effects were explained as the consequence of lattice defects formed in the neighbourhood of precipitate particles.

15148 THE EFFECT OF ADDITIONS OF A THIRD COMPONENT ON AGEING OF ALUMINIUM/SILVER ALLOYS.

R.R.Zakharova and N.I.Buinov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 375-81 (Sept., 1960). In Russian.

The effect of Cu (0.05-2.42 at.%), Mg (0.75%), Zn (2.36%), and Si (2.22%) additions on ageing of Al—5 at.% Ag alloy was studied by X-ray diffraction, electron microscope examination, and hardness measurements. It was found that the distribution of the third component depends on its solubility in Ag and Al and on its ability to form intermetallic compounds with these elements. Correspondingly, the concentration of Cu and Si is the same in both the matrix and the Guinnier—Preston (GP) zones of the alloy studied, whereas Mg and Zn concentrate mainly in the GP zones. The effect of these additions on low temperature ageing was found to be associated with the degree, D, of dissimilarity between the lattices of the matrix and the GP zones. When D increases, as in the case of the Mg and Zn additions, the stability of the GP zones decreases and the rate of decomposition of the solid solution increases. If, as in the case of the Cu and Si addition, D raemins constant, neither the stability of the GP zones nor the ageing rate is affected. This law is valid only for relatively small additions of the third component which do not unduly increase the degree of supersaturation of the solid solution. M.H.Sloboda

15149 INVESTIGATION OF AGEING OF SILICON—MANGANESE BRONZE BY MEASUREMENTS OF MAGNETIC SUSCEPTIBILITY AND ELECTRICAL RESISTIVITY.

Z.Z.Brainina, M.N.Mikheev, P.G.Rudomanov and V.P.Selyakhina.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 490-2 (Sept., 1960). In Russian.

The variation of magnetic susceptibility and electrical resistivity of cold-rolled bronze containing 2.75-3.5% Si and 1.0-1.5% Mg was studied isothermally at 20-500°C. The results indicated that alloys of this type do, in fact, age, and that alloys with a high Si content are particularly prone to ageing which is most pronounced at ~ 300°C. Cracking of these alloys can be avoided by limiting the Si content to 3.0%, or by introducing alloying additions which widen the solid solubility range. M.H.Sloboda

15150 THE EFFECT OF FATIGUE DEFORMATION ON THE DISPERSION OF SUBSEQUENT PRECIPITATION IN ALUMINIUM ALLOYS.

C.A.Stubbington.
J. Inst. Metals (GB), Vol. 88, Pt 5, 227-32 (Jan., 1960).

Metallographic and quantitative comparisons were made between the hardening produced by unidirectional strain and that produced by cyclic strain, and their effects on the subsequent ageing of aluminium—12.5% magnesium alloy. Some metallographic observations on the influence of cyclic strain on the subsequent precipitation occurring in aluminium—30% zinc alloy and in a commercial high-strength alloy (DTD 683) are also included. The mechanism by which precipitation is modified is discussed.

15151 MECHANISM OF AGEING OF LEAD ALLOYS.

L.N.Larikov.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 397-407 (1958). In Ukrainian.

The nearer the composition and crystalline structure of the precipitate are to the composition and structure of the basic solid solution, the more homogeneous is the mechanism of precipitation of the latter. This leads to a prolonged conservation of the hardened state at certain temperatures related to the absolute melting temperature of the alloy base. The stability of the hardened state under these conditions is also determined by the action of the hardening alloying element on the characteristic temperature and the kinetics of the softening and recrystallization processes of the alloy base.

15152 EFFECTS OF LEAD, BISMUTH, SILVER, AND ANTIMONY ON GRAIN GROWTH IN ZONE-REFINED TIN.

E.L.Holmes and W.C.Winegard.
J. Inst. Metals (GB), Vol. 88, Pt 11, 468-70 (July, 1960).

Experiments were performed to observe the effects of small additions of lead, bismuth, silver, and antimony on grain growth in zone-refined tin. A growth law:

$$D = K_0 \exp - \frac{Q_G}{RT} .\exp - \frac{Q^1}{R} \frac{1}{T} - \frac{1}{T_m} .t^{n}$$

was obtained, which applied to zone-refined tin containing small amounts of lead, bismuth, or silver. In this expression Q_G is the activation energy obtained for grain growth in zone-refined tin, Q^1 is a factor dependent upon the particular impurity and its concentration, T_m is the melting temperature of tin, K_0 is a constant, and D is the average grain diameter at a time t, wher t is a corrected time such that D = 0 at t = 0. Grain growth wa retarded to an increasing extent in going from lead to bismuth silver, with the rates approaching a common value near the me point of tin. The effect of antimony, however, was different, in that the rate of grain growth was not only markedly reduced cl to the melting point of tin, but was also almost independent of temperature, and the above growth law could not be applied.

EFFECT OF THE PRECIPITATION OF DISSOLVED MnCl N
THE LOW-TEMPERATURE THERMAL CONDUCTIVITY OF N
See Abstr. 14190

15153 A THEORY OF SCATTERING OF X-RAYS IN DISTORTED HETEROGENEOUS SOLID SOLUTION

M.A.Krivoglaz.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 5, 641-56 (May, 1960). In Russian.

An analytical study of X-ray scattering in a solid solution i presented in which the crystal lattice distortions, associated wi the presence of spherical precipitates of a second phase, are ta into account. The decrease in the intensity of the normal diffra due to lattice distortions is much more pronounced in a heterogeneous crystal than in a single-phase crystal of the same composi and the distortion of diffusion scattering in the former case is characterized by certain specific features. In the case of a hea distorted lattice and large diffraction indices, the intensity of normal diffraction becomes very small, and the diffusion scatte X-rays converge to form a narrow, funnel-shaped beam which could, in experimental work, be regarded as a broadened "quasi line". M.H.Slo

15154 DETERMINATION OF THE NUMBER OF INDEPEN PARAMETERS OF SHORT- AND LONG-RANGE OR IN MULTI-COMPONENT SOLID SOLUTIONS.

A.N.Men'.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 801-9 (June, 1960). In Russian.

An analytical method is proposed. For long-range order, t distribution of atoms on both equivalent and non-equivalent lattic sites is taken into account, the equivalent sites being those that be mutually superposed by some change in the crystal symmetry For short-range order, not only the atomic distance but also the distribution of atoms in the intermediate coordination spheres is considered. A method is also given of determining the number o independent parameters of short-range order taking into account the adjacent sites of the second order. M.H.Slo

15155 COTTRELL ATMOSPHERE IN DILUTE SOLID SOLUTIONS.

V.M.Danilenko.
Fiz. Metallcv i Metallovedenie (USSR), Vol. 9, No. 6, 810-14 (Ju 1960). In Russian.

It is shown analytically that if the atomic interaction is taken into account, it is possible to study the process of formation of Cottrell atmospheres at temperatures approaching $kT \cong |v_{Dc}|$ (where v_{Dc} is the energy of the elastic interaction between disloc tions and impurity atoms), at which the simplified Cottrell theory is not valid. The properties of Cottrell atmospheres at low temp ture depend essentially on the magnitude of the energy of solution given by $w = (V_{AA} + V_{BB})/2 - V_{AB}$, where V's denote energies o interaction between various combinations of atoms A and B. If $w > 0$, the concentration of surplus impurity atoms cannot exceed the so-called saturation concentration, c_s, given by $c_s - c_0 = |v_{Dc}|/2(v_c + zw)$, where c_0 is the concentration of the impurity atoms in the undistorted crystal regions, v_c is the energy of elast interaction between impurity atoms, and z is the coordination num If both w and $(v_c + zw)$ are negative, the concentration of impurity atoms near a dislocation may approach 1. At $(v_c + zw) > 0$, the average concentration of impurity atoms in a solid solution at low temperature may be considerably higher than that in the undistort crystal regions. This difference depends both on the dislocation density in the crystal and on the magnitude of $(v_c + zw)$ to which it is inversely proportional. See also following abstract.

M.H.Slobo

15156 THE SOLUBILITY OF IMPURITIES IN SOLIDS.

V.M.Danilenko.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 940-2 (June, 1960). In Russian.

Continuation of previous work (see preceding abstract). It is it in the case of a dilute solid solution in which the solubility ute decreases with decreasing temperature, the concentra- e Cottrell atmosphere may approach unity at low tempera- a result of which sub-grains of a second phase may be nder favourable conditions. M.H.Sloboda

15 7 THE RECRYSTALLIZATION CHARACTERISTICS OF DILUTE ALUMINIUM SOLID SOLUTIONS PREPARED ONE-REFINED ALUMINIUM BY LEVITATION MELTING.

le, J.W.H.Clare and H.J.Lamb.

Metals (GB), Vol. 88, Pt 8, 365-8 (April, 1960).

recrystallization behaviour of dilute solid solutions of silicon, magnesium, manganese, iron, and chromium in um prepared from zone-refined aluminium by levitation has been studied. All the alloying elements increased the allization temperature, additions of the order of 0.0001 at.% ufficient to produce most of the retardation of recrystalliza- he various solute elements can be divided into two groups: t, comprising silicon, copper, and magnesium, increased the allization temperature by 50°-100° C; however, the recrystal- temperatures of these alloys, even with concentrations of the f 0.04-0.05 at.% were less than that of conventional super- luminium under comparable experimental conditions. The group, consisting of iron, chromium, and manganese, ed the recrystallization temperature by ~ 200° C. Since licon, and copper are the major impurities in super-purity um, it is concluded from these results that the iron content najor factor controlling its recrystallization.

1 58 THE LATTICE PARAMETERS OF THE ALPHA SOLID SOLUTIONS OF COPPER—ZINC—NICKEL AND R—ZINC—MANGANESE.

G.A.Chadwick and B.B.Argent.

Metals (GB), Vol. 88, Pt 7, 318-19 (March, 1960).

s shown that the alteration in the lattice parameter of caused by the solution of zinc and nickel is slightly less e sum of the changes due to each other solutes considered tely. Zinc and manganese together expand the copper lattice eater extend than the sum of the expansions due to each of the considered separately. These deviations from additivity are y explicable in terms of variations in the degree of order t in the systems.

59 INVESTIGATION OF DECOMPOSITION OF SUPER-SATURATED SOLID SOLUTIONS OF COPPER IN ANIUM.

A.M.Elistratov and P.R.Kamadzhiev.

rerdogo Tela (USSR), Vol. 2, No. 11, 2950-60 (Nov., 1960). sian.

ecomposition of supersaturated solid solutions of Cu in Ge was d by X-ray diffraction technique, and by measurements of ical resistivity, ρ, and thermo-e.m.f. The two-dimensional ction effects produced by specimens heated for various ls at 500-650° C, were attributed to submicroscopic voids d during this treatment in the Ge crystal on a plane parallel of the (111) planes of the Ge lattice. The concentration of (up to 20 A in diameter, and 600 A long) reached 10^{12} cm^{-3}. the anomalous diffraction effects due to the formation of pores appeared first when ρ of the specimens attained its num, i.e., after the bulk of Cu atoms had been rejected from lid solution, it was inferred that the micropores are not d until the nuclei of the new phase reach a certain critical The decrease in ρ on further heating was attributed to the rance of acceptors, associated with the deformation-induced e defects in Ge. In analogy to those metallic solid solutions e decomposition is accompanied by large volume changes, the nposition of supersaturated solid solution of Cu in Ge had ogeneous character and, in spite of the very low concentration e solute atoms, resembled in other respects (formation of -voids, development of mosaic structure) the corresponding omena taking place in metallic solid solutions.

M.H.Sloboda

5160 THE SOLID SOLUBILITY OF ANTIMONY IN TIN.

B.L.Eyre.

ist. Metals (GB), Vol. 88, Pt 5, 223-4 (Jan., 1960).

Microexamination of specimens brought to equilibrium by aling has shown that the solubility of antimony in tin increases 0.75 wt.% at 50°C to 6.6 wt.% at 223°C. These results and e of Hanson and Pell-Walpole (1936) for higher temperatures used to plot the solid solubility of antimony in tin.

15161 LATTICE SPACINGS OF SILVER—MAGNESIUM SOLID SOLUTIONS IN THE ORDERED AND RANDOM CONDITIONS.

R.A.Buckley, H.J.Axon and J.Conacher.

J. Inst. Metals (GB), Vol. 88, Pt 5, 225-6 (Jan., 1960).

Lattice-spacing measurements are reported for the silver-rich solid solution in the disordered condition. The range of ordering was determined by electrical-resistance measurements on slowly cooled and reheated wire specimens, and the lattice spacings of the fully ordered structures were measured.

15162 A STUDY OF THE TITANIUM—SILVER SYSTEM.

M.K.McQuillan.

J. Inst. Metals (GB), Vol. 88, Pt 5, 235-9 (Jan., 1960).

In a micrographic study, supplemented by X-ray work, particular emphasis was placed on the interrelationships between the terminal solid solutions and any intermetallic compounds formed. The results, which established the formation of TiAg by the reaction: β-Ti + liquid $\rightleftharpoons$ TiAg at 1030° ± 5°C, and of Ti_3Ag by the reaction: β-Ti + TiAg $\rightleftharpoons$ Ti_3Ag at 930° ± 3°C, reconcile the conflicting findings of several previous investigators. The existence of a peritectic reaction, TiAg + liquid $\rightleftharpoons$ Ag, at 1017° ± 3°C indicates that there is appreciable solubility of titanium in solid silver.

15163 ELECTRICAL MIGRATION OF IRON AND ALUMINIUM IN IRON—ALUMINIUM ALLOYS.

Ye.I.Khar'kov and P.P.Kuz'menko.

Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 3, 389-98 (1959). In Ukrainian.

The d.c. migration in alloys with 23, 35 and 40 at. % of Al was studied using a procedure similar to that described previously (Abstr. 14319 of 1961). The migration of iron was followed by applying a radioactive isotope of Fe^{59}; that of aluminium, by the change in weight of the cathode and anode parts of the sample, due to the migration of the substance in direct current. A detailed description of the weighing procedure is given. At current densities of 13 to 35 A/mm² aluminium migrates to the cathode and iron to the anode. The dependence of the velocity of migration V on the temperature T and the current density i was investigated for alloys with 40 at. % Al; the activation energy of the process was determined for both components, as well as the dependence of the coefficient of diffusion of iron on the temperature. It was found that at temperatures exceeding 1250°C the migration velocities V_{Fe} and V_{Al} begin to change anomalously, which may be explained by the change in the Fe and Al ions. Investigations of the dependence of the migration velocity on the current density showed that for the interval 13-35 A/mm² this dependence is linear within the limits of experimental error. Hence, the authors consider that under the conditions indicated in the foregoing the effect on migration of the "electronic wind" — found by them in the case of silver — may be neglected in the case of iron—aluminium alloys, and the migration effect may be regarded as the result of the action of the field on atomic cores. Considering that the Einstein ratio, allowing for the coefficient of correlation f (Abstr. 1671 of 1957), is applicable to metallic systems it was employed to determine the charges of the Fe and Al ions. For an alloy containing 40 at. % of Al, $q_{Fe} = -2.6$, $q_{Al} = +2$ in the temperature region 1000-1250°C. In the 1250-1340°C range the absolute values of the charges decrease rapidly. It is thus shown that considerable ionic binding occurs in Fe—Al alloys with a high Al content.

STRUCTURE OF SURFACE SCALE FORMED IN REACTIVE DIFFUSION. See Abstr. 14291

REACTIVE DIFFUSION IN "METAL—COMPOSITE GAS" SYSTEMS. See Abstr. 14310-11

OTHER SOLID FORMS

REFRACTIVE INDEX AND PORE STRUCTURE OF ACID-LEACHED SURFACE LAYER OF GLASS. See Abstr. 14573

THE D.C. CONDUCTIVITY AND STRUCTURE OF CALCIUM BOROALUMINATE GLASSES. See Abstr. 14397

15164 THEORY OF NUMBERS AND THE PROBLEM OF POLYMERIZATION.

V.S.Nanda and R.K.Pathria.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 700-10 (Nov. 26, 1960).

"The number theory" approach to the problem of degradation of polymers, developed in earlier papers, is employed here in order to study the problem of polymerization. For the case of condensation polymers, the discussion includes the problem of molecular weight stabilization and multi-chain polymerization. For the case of addition polymers, where the mechanism of chain termination is of great importance in determining the nature of the statistical distribution, a formulation which includes all the important mechanisms is given. It is noticed here that in order to obtain the expressions for the size distribution and averages for the overall material, the necessary integrations, in general, cannot be carried out. A procedure is, however, indicated in which the various integrals are expressed in the form of series expansions which are rapidly convergent whenever the fractional change in the mean degree of polymerization during the process is small.

15165 A SHORT REVIEW OF DISCUSSIONS OF THE GLASS TRANSITION, SECOND-ORDER TRANSITION, AND RELAXATION PHENOMENA IN HIGH POLYMERS.

A.Nishioka.

Suppl. Progr. theor. Phys. (Japan), No. 10, 137-41 (1959).

"Relaxation phenomena of polymers" Meeting, Kyoto, 1958 (see Abstr. 6449 of 1961). The author reviews a discussion held at the High Polymer Symposium in Tokyo in 1956. The nature of the glass transition was discussed from the relaxation and the thermodynamical viewpoints. The author considers that from the former viewpoint the glass transition occurs at a definite temperature independent of the method of measurement and quotes supporting evidence. Thermodynamically, the important factor is the rate of cooling of the sample. The relation between the two viewpoints is briefly discussed. The correspondence between n.m.r. and dielectric and mechanical relaxation observations in polymers was discussed at the Symposium and the author outlines theoretical modifications to the theory of Bloembergen, Purcell and Pound (Abstr. 2529 of 1948), presented by Miyake and Odajima. Line-width narrowing below the glass temperature is discussed and alternative measures of line width are mentioned. A new theory of the β-transition in polar polymers by Tanaka is outlined. See also two following abstracts. R.G.C.Arridge

15166 RELAXATION PHENOMENA AND MOLECULAR MOTION IN SOLID STATE OF HIGH POLYMERS.

S.Nohara.

Suppl. Progr. theor. Phys. (Japan), No. 10, 159-73 (1959).

"Relaxation phenomena of polymers" Meeting, Kyoto, 1958 (see Abstr. 6449 of 1961). Comparison of n.m.r., mechanical and dielectric relaxation in several polymers. The correlation of dispersion regions with modes of molecular motion is discussed on the basis of results obtained by the author and others. Polymers studied: natural rubber and Buna-N, polystyrene, polyvinyl chloride and Kel-F, nylon-6, Terylene and polyvinyl alcohol, Teflon and polyethylene. The author details present-day interpretations of the dispersion regions in these polymers and puts forward new ones for the low-temperature transition in terylene and in polyethylene. The effects of moisture and of crystallinity in polyvinyl alcohol are discussed in relation to the shape of the proton resonance line. The use of n.m.r. in estimating crystallinity is briefly discussed. R.G.C.Arridge

15167 TRANSITION PHENOMENA IN HIGH POLYMERS.

R.Chûjô.

Suppl. Progr. theor. Phys. (Japan), No. 10, 198-209 (1959).

"Relaxation phenomena of polymers" Meeting, Kyoto, 1958 (see Abstr. 6449 of 1961). This is a brief review of Japanese theoretical research on the transition phenomena in high polymers. The first two sections are devoted to the theories of second-order transition phenomena, from the relaxation standpoint using the Rouse model and from the thermodynamic, using hindered rotation assuming only nearest neighbour interaction. The results for T_m/T_g are 1.45 and 2.41 for antisymmetric and symmetric molecules respectively and the results are compared with experiment. The rotational transition in crystallites is briefly treated and the result for C_v is compared with data for polytetrafluoroethylene. The application of n.m.r. to the study of side-group rotational transitions is discussed in the last section. R.G.C.Arridge

15168 FEATURES AND INTERPRETATION OF SORPTION PROCESSES IN POLYMER—VAPOR SYSTEMS.

H.Fujita, A.Kishimoto and H.Odani.

Suppl. Progr. theor. Phys. (Japan), No. 10, 210-26 (1959).

"Relaxation phenomena of polymers" Meeting, Kyoto, 1958 (see Abstr. 6449 of 1961). A summary is given of sorption and desorption in concentration-dependent polymer—vapour systems The chief features of Fickian and non-Fickian sorption are det Details are given of new experiments by the authors on several polymers using a differential sorption method and the interpret of the results is by a diffusion—relaxation mechanism involvin characteristic motions of the network chain under swelling pre R.G.C.Ar

MECHANICAL DISPERSIONS AND TRANSITION PHENOM IN SEMICRYSTALLINE POLYMERS. See Abstr. 14851

15169 THE DETERMINATION OF CONCENTRATION DISTRIBUTION FOR ALLOYS OF HETEROGENEO METAL POWDERS.

O.I.Raichenko.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 3, 408-18 (1958). In Ukrai

Considers the concentration distribution function in powder solids prepared from two metals with unlimited mutual solubili different stages of mutual diffusion in the solid phase. The sol of the diffusion equation for a two-component powder model wit arbitrary average concentration is used to theoretically determ the concentration distribution. The typical features of these distributions are revealed on the distribution histograms calcul for the case of 80% A + 20% B. In any intermediate state the function tends to its main maximum more abruptly from the sid the rich component and less abruptly from the side of the poor component. The maximum of the function moves from the rich component to the average concentration of the solid, as diffusio develops (the degree of sintering rises). In the experimental pa the investigation the concentration distribution functions were fo (by means of X-ray analysis) for copper—nickel solids at differ degrees of sintering. A comparison of the theoretical and exper mental results reveals both similar and dissimilar features. Th results of the study demonstrated that the non-ideality of mixtur and the presence of porosity leads to a retardation of the homogenization process as compared with the theoretical prediction.

15170 THE PART PLAYED BY ADMIXTURES IN THE FORMATION OF DIFFUSION POROSITY.

Ya.Ye.Hehuzin and N.M.Ovcharenko.

Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 696-8 (1958). In Ukraini

Presents some results obtained in investigations into the evaporation of Zn from α-brass (see also Abstr. 4455 of 1958). F.Lach

THE MOLECULAR STRUCTURE AND MECHANICAL PROP IES OF POLYETHYLENE TEREPHTHALATE FIBERS. See Abstr. 14136

DYNAMIC MECHANICAL PROPERTIES OF STRETCHED NATURAL RUBBER. See Abstr. 14861

Surfaces . Films . Adsorption

15171 THE SURFACE ENERGY OF SOLID NICKEL.

E.R.Hayward and A.P.Greenough.

J. Inst. Metals (GB), Vol. 88, Pt 5, 217-20 (Jan., 1960).

The surface energy of pure nickel in argan was measured b method of Udin, Shaler, and Wulff (1949). At 125°C it is 1850 erg cm^{-2}, and at the melting point, 1725 erg cm^{-2}. These results are consistent with theoretical estimates. Experimental evidence indicates that the wires deform by the Nabarro—Herri diffusion mechanism. The activation energy for self-diffusion derived in this work is 49.5 kcal/g-atom, which is considerably less than the value of 66.5 kcal/g-atom obtained by the radioacti tracer technique.

15172 METHODS OF REDUCING THE ENERGY DISSIPATE IN THE SURFACE LAYERS OF QUARTZ.

A.G.Sma

Kristallografiya (USSR), Vol. 4, No. 6, 862-6 (Nov.-Dec., 1959). In Russian.

Methods are proposed for reducing the loss of energy in the surface of quartz crystals used to stabilize standard-frequency sources or in precision frequency meters; the Q can be raised t $5\text{-}20 \times 10^6$. The methods involve grinding the crystals with abra sives used in an appropriate sequence; each successive grinding removes the surface damage caused by the previous grinding, a the crystal is finally polished until the asymptotic value of Q is attained. [English translation in: Soviet Physics—Crystallogra (USA). Vol. 4, No. 6, 818-21 June, 1960)].

1 3 ON SOME DECORATION EFFECTS OBTAINED AT THE CLEAVAGE SURFACES OF ZINC MONOCRYSTALS BY VACUUM EVAPORATION. P.Spinedi and M.Crudeli.
sci. (Italy), Vol. 30, No. 7, 1068-70 (July, 1960). In Italian.
surface features observed with the microscope after the
n of zinc crystals under controlled conditions are also
d after further evaporation of zinc onto the surfaces.
C.A.Hogarth

1 4 THE WORK FUNCTION OF THE GOLD-BARIUM SYSTEM AND METHODS OF ITS STABILIZATION.
ishkin and I.L.Sokol'skaya.
rdogo Tela (USSR), Sbornik [Supplement] II, 276-85 (1959).
an.
work function of the system consisting of barium and gold
leposited on tungsten was 3.3 eV, indicating the formation of
metallic compound, possibly $BaAu_8$. Stabilization was
l by heating for 20 min at 700° C. A.Tybulewicz

1 5 CHAIN WALL IN PERMALLOY THIN FILMS.
Y.Gomi and Y.Odani.
. Soc. Japan, Vol. 15, No. 3, 535 (March, 1960).
study of 80-20 Permalloy on microscope slides at pressures
$.0^{-5}$ mm. Hg. Observations suggest that scratches are the
of the type of deposit obtained whether cross-tie wall or
all type. T.C.Toye

76 TEXTURE OF MATERIAL DEPOSITED ON AN AMORPHOUS BACKING.
latnik and Yu.F.Komnik.
lografiya (USSR), Vol. 5, No. 5, 775-8 (Sept.-Oct., 1960).
sian.
der certain conditions, a molecular beam striking an amor-
material may condense to give a nucleation texture whose
es not vary in direction with the direction of the beam.
ucleation texture is reported for thin films of Bi and Sn
ted on collodion. The conditions giving rise to such textures
nsidered. [English translation in: Soviet Physics—Crystal-
hy (USA), Vol. 5, No. 5, 738-40 (March-April, 1961)].

77 ON THE STRUCTURE OF THIN SALT FILMS CONDENSED AT LOW TEMPERATURES. IV. THE
MS KCl/TlCl AND RbCl/TlCl. H.Mittendorf.
s. (Germany), Vol. 163, No. 3, 321-38 (1961). In German.
or Pt III, see Abstr. 5260 of 1959. Thin films of the binary
ns KCl/TlCl and RbCl/TlCl are condensed on to a substrate
w temperature (quenching condensation). Debye-Scherrer
raphs are taken immediately after condensation and during
ing. After condensation at 20° K the films have a high degree
order, and are even found under certain conditions in an
hous state. The films exhibit CsCl-type structure for high
ntrations of TlCl, and NaCl-type structure with increasing
ntrations of KCl and RbCl. Diagrams of the frozen-in states
condensed films are compared with the usual equilibrium
ms of binary systems.

178 THE STRUCTURE AND FORMATION OF BLACK EVAPORATED LAYERS OF BISMUTH.
tsche, F.Wolf and A.Schaber.
turforsch. (Germany), Vol. 16a, No. 1, 31-6 (Jan., 1961).
rman.
he particle sizes of black and reflecting Bi deposits, evapor-
n air under reduced pressure at various heating rates and
e-substrate distances, were measured by X-ray low-angle
ering techniques. Particles of Bi, detected by Tyndall
ering in the evaporating chamber, were examined by electron
oscopy. It was concluded, that black layers were formed by
ition of Bi which had already coagulated to particles before
ing the substrate. This process is not only governed by the
ure of the residual gas, but also by the speed, temperature
ibution and vapour pressure of the metal within the convection
nt between furnace and substrate. With the same residual gas
ure, black, metallic or intermediate layers were obtained, by
ng the other conditions. J.Franks

5179 MODIFICATIONS OF BERYLLIUM AND IRON IN FILMS CONDENSED ON TO COLD SUBSTRATES.
Lazarev, E.E.Semenenko and A.I.Sudovtsov.
ksper. teor. Fiz. (USSR), Vol. 40, No. 1, 105-8 (Jan., 1961).
ssian.
A study was made of the variation with temperature of the electrical resistance of films of beryllium, iron and copper, condensed on to substrates cooled with liquid helium, hydrogen, or nitrogen. In the beryllium films, the existence of two low-temperature modifications, obtained under differing conditions of condensation, was discovered. One of these modifications becomes superconducting at ~ 8°K and exists over the temperature region up to ~ 40°K; the other becomes superconducting at ~ 6°K and is stable up to at least 130°K. In the iron films a polymorphic transition is found at a temperature of ~ 40°K. No polymorphic transitions are observed in copper films. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 75-7 (July, 1961)].

15180 CONTACT POTENTIAL MEASUREMENTS ON CdS SINGLE CRYSTALS. F.Eckart and H.Schulz.
Z. Phys. (Germany), Vol. 164, No. 1, 83-92 (1961). In German.

Variations in the surface escape energy of CdS single crystals, under various surface loads and after various forms of treatment, were investigated by measuring the contact potential. An interpretation of the results is attempted on the hypothesis of a concentrated surface film.

"VERNI-RAY", AN INSTRUMENT TO MEASURE THE UNIFORMITY OF THIN FOILS. See Abstr. 12840

INTERNAL PHOTOEFFECTS IN THIN PHOTOCONDUCTIVE LAYERS. See Abstr. 14499

TRANSPARENT LUMINESCENT FILMS BY SOLUTION SPRAYING. See Abstr. 14654

DEPOSITION OF THIN Fe—Ni ALLOY FILMS. See Abstr. 14715

NONLINEAR EFFECTS OF Z-DIRECTED SPIN WAVES IN THIN FILMS. See Abstr. 14717

EPITAXY AND TWINNING IN FOILS OF SOME NOBLE METALS. See Abstr. 15011

15181 GAS ADSORPTION ON THE SURFACE OF AN IDEAL SEMICONDUCTOR. F.García Moliner.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56, No. 7-8, 159-64 (July-Aug., 1960). In Spanish.

A statistical method developed by Landsberg (Abstr. 10635 of 1959) is applied to the problem of determining the relative concentrations of molecules M of the same gas adsorbed in different forms on the surface of an ideal semiconductor. Explicit formulae, identical to those already known through other methods, are given for the case in which there are three states M^+, M^0, M^-. It is pointed out that, other factors being equal, the position of the Fermi level (a bulk property) determines some of the surface properties.
L.Pincherle

15182 ELECTRONIC AND ADSORPTION PROPERTIES OF ATOMIC BARIUM FILMS ON TUNGSTEN.
Ya.P.Zingerman, V.A.Ishchuk and V.A.Morozovskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2276-86 (Sept., 1960). In Russian.

The following adsorption parameters were found: condensation coefficient, heat of evaporation, mean value of the dipole moment of adsorbed atoms, as well as dependences of these parameters on the surface density n. The work function of the W—Ba system (ϕ) fell monotonically with increase of n, reaching at $n \cong 5\text{-}6 \times 10^{14}$ atoms/cm^2 a value close to the work function of massive barium samples; this relationship held only for surface densities up to monatomic film thickness. The minimum on ϕ(n) curves was due to residual gases present in the apparatus. [English translation in: Soviet Physics—Solid State (USA), Vol. 2, No. 9, 2030-8 (March, 1961)].
A.Tybulewicz

15183 STUDY OF THE ADSORPTION OF Ba ATOMS AND BaO MOLECULES [ON TUNGSTEN] IN A FIELD-EMISSION PROJECTOR. V.M.Havrȳlyuk and V.H.Yazyeva.
Ukrayin fiz. Zh. (USSR), Vol. 3, No. 3, 421-4 (1958). In Ukrainian.

15184 RELEASE OF RADIOACTIVE INERT GAS LABEL FROM SURFACES OF SOLIDS DURING HYDRATION AND DEHYDRATION. C.Jech.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8 No. 4, 179-85 (Oct., 1960).

The results presented show that both the processes of incorporation of water into, as well as its removal from, the surface structure of solids are accompanied by the release of a fraction of the inert gas label, introduced there by ionic bombardment. The extent and time dependence of the release during surface hydration are dependent on the nature and porosity of the labelled substance. By following the release in the course of thermal dehydration, it is possible to discern initial stages of individual dehydration steps. The method can provide new information on changes produced in the structure of the outermost layers of a solid during processes of adsorption and desorption.

15185 A RADIOTRACER STUDY OF AN OPTICAL METHOD FOR MEASURING ADSORPTION.
L.S.Bartell and J.F.Betts.
J. phys. Chem. (USA), Vol. 64, No. 8, 1075-6 (Aug., 1960).

The elipticity of polarized light reflected from metal surface is known to provide a very sensitive measure of the thickness of adsorbed films. The present study examines the reliability of this method for less than monolayer coverage with special reference to the surface roughness. A direct radiotracer method is employed to assess surface coverage of adsorbate and electron micrographs are prepared to estimate surface roughness. It is suggested that the optical readings are proportional to the amount of material adsorbed even for fractional monolayer coverage. F.A.Baker

POLARIZATION OF ADSORBED ATOMIC HYDROGEN. See Abstr. 13970

SORPTION PROCESSES IN POLYMER—VAPOUR SYSTEMS. See Abstr. 15168

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

15186 STRUCTURAL DEFECTS CAUSING VARIATION OF THE INTENSITY OF X-RAY DIFFRACTION PATTERNS.
O.N.Shivrin and L.M.Gerasimova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 586-9 (Oct., 1960). In Russian.

A method is described by which the relative magnitude of the effect of the primary and secondary extinction on the X-ray pattern intensity can be quantitatively determined by X-ray analysis of massive specimens, whereby the necessity is avoided of using powder specimens whose mosaic structure has characteristics different from those of the structure of plastically deformed, massive metal. M.H.Sloboda

15187 X-RAY DIFFRACTION STUDY OF THE STRUCTU DISTORTIONS OF STEEL DURING WEAR.
V.D.Sergeeva and Yu.S.Terminasov.
Kristallografiya (USSR), Vol. 5, No. 4, 580-4 (July-Aug., 1960)
In Russian.

Variation in block size and microstrain due to rolling fric were investigated as a function of load on specimen, friction p and initial state, using Fourier analysis of line broadening. In addition, the influence of these parameters on the distortion of crystal structure at different depths in the deformed surface has been studied. It is shown that the process of plastic defor in rolling friction is accompanied by fragmentation of the crys blocks and an increase in microstrain; the development of thes effects occurs simultaneously, with variation in the microhard Maximum development of these structural characteristics was found on the surface of the specimens in the first stage of the The intensity changes of some diffraction lines were studied, a is shown that some of these changes are due to the presence of texture. [English translation in: Soviet Physics—Crystallogra (USA), Vol. 5, No. 4, 555-9 (Jan.-Feb., 1961)].

15188 STUDY OF THE FORM AND SIZE OF THE X-RAY INTERFERENCE SPOTS ON ELASTICALLY DEFO TRANSFORMER STEEL. V.M.Finkel' and V.N.Berezovskii.
Kristallografiya (USSR), Vol. 5, No. 6, 896-903 (Nov.-Dec., 19
In Russian.

A number of reflections on the X-ray photographs of stres and destressed polycrystalline transformer steel were studied Reversible variation of a number of reflections up to the limit elasticity and abrupt rotations of individual spots were observe [English translation in: Soviet Physics — Crystallography (USA Vol. 5, No. 6, 853-60 (May-June, 1961)].

15189 THE REFLECTION ANOMALIES DUE TO THE PH RELATIONS BETWEEN THE CRYSTAL DOMAINS.
T.Tomita.
Sci. Rep. Saitama Univ. A (Japan), Vol. 3, No. 3, 179-89 (1960)

The diffuse and superlattice reflections observed for silic carbide crystals are discussed in connection with the phase relations between orientated crystal domains. The intensity c due to the phase relations and the effect of the interstices betw the domains are considered separately.

THE SCATTERING OF SUBTHERMAL NEUTRONS BY H_2O CH_2O_2 AND C_6H_6. See Abstr. 13429

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

15190 CONVECTION WITH CHEMICAL REACTION.
P.Valentin.
Ann. Phys. (France), Vol. 6, No. 3-4, 271-329 (March-April, 1961).
In French.

Describes experiments carried out with a body (Pt lamina) placed within a fluid in motion, in which a chemical reaction (combustion) takes place, the heat transfer to this body being studied. In the simplest case combustion takes place on the surface only; at higher temperatures the combustion reaches the fluid near the wall. Diffusion was shown to play the main part in regions of combustion. Combustion in a homogeneous phase (near the lamina) can be interpreted as a purely thermal reaction process.
F.Lachman

15191 ON THE BASIC LAWS OF REACTION KINETICS.
M.Podlaha.
Czech. J. Phys., Vol. 11, No. 7, 469-75 (1961).

Gives the basic laws necessary and in principle sufficient for constructing a system of differential equations for any reaction kinetic process. A new and more exact formulation of two of the basic laws (the principle of superposition of partial reaction velocities and the Guldberg—Waage law) is made possible by an exact definition of the important quantities of this subject. In conclusion the paper points out the difference between the gene form of the differential equations for concentrations of compon expressed in moles per unit weight and that for concentrations components expressed in moles per unit volume.

SELF-IGNITION OF HYDROCARBON-AIR MIXTURES IN SHOCK WAVES. See Abstr. 12916

15192 DETERMINATION OF THE DETONATION CHARACTERISTICS OF SOLID EXPLOSIVES.
J.Berger, J.Favier and Y.Nault.
Ann. Phys. (France), Vol. 5, No. 7-8, 771-803 (July-Aug.); No.
1143-76 (Sept.-Oct., 1960). In French.

15193 THERMODYNAMIC PROPERTIES OF FREE RADICALS. I. D.V.S.Jain and M.M.Kapoor.
Proc. Nat. Inst. Sci. India A, Vol. 27, No. 2, 101-5 (March 26,

The thermodynamic properties S^0, Cp^0, $(H^0-H_0^0)/T$ and $-(F^0-H_0^0/T)$, for methyl, trifluoromethyl and trichloromethyl radicals are calculated from $298{\cdot}1^0$ to 1500^0K by the methods statistical thermodynamics with the help of suitable assumptio for the values of molecular parameters and fundamental freque of the species.

THERMODYNAMIC PROPERTIES OF FREE RADICALS. II. D.V.S.Jain and M.M.Kapoor.

it. Inst. Sci. India A, Vol. 27, No. 2, 106-7 (March 26, 1961).
rmodynamic properties S^0, Cp^0, $(H^0-H_0^0/T)$, $-(F^0-H_0^0/T)$ ethoxy radical are estimated from 298·1° to 1500° K. ble assumptions are made for the molecular constants and amental frequencies for the purpose of these calculations.

THE KINETIC SOLVENT ISOTOPE EFFECT IN ACID CATALYSIS REACTIONS WITH SLOW PROTON 'ER. A.V.Willi.

forsch. (Germany), Vol. 16a, No. 2, 162-9 (Feb., 1961).
an.
kinetic deuterium isotope effect is approximately calculated eaction H_3O^+ + substrate → product using statistical mech- artition function and different (linear) models of the tran- ate. The influence of the tunnel effect is considered. A mit of k_H/k_D = 1.6 at 25° C is found. In four of six present- nples the experimental values lie between 1.7 and 4.3. In r two examples the values are in the neighbourhood of 1.0. umptions underlying the chosen models are discussed.
W.Good

ELECTROCHEMISTRY

6 A NEW METHOD TO DETERMINE HYDRATION ENERGY OF ION. Y.Ishida.

. Soc. Japan, Vol. 15, No. 9, 1707 (Sept., 1960).
ng a method based on the double-shell model for hydration of ydration energies are calculated for Na^+, K^+, Mg^{2+}, Ba^{2+} .
J.Dutton

7 THEORY OF THE COMPLEX ACTIVITY. F.Heitz.

. Cent. Nat. Rech. Sci. (France), No. 53, 263-93 (Dec., 1960).
ch.
e mathematical presentation of the activity of electrolytic is is simplified by the introduction of a new concept: the angle ω:

$$\omega = Z\sqrt{\frac{e^2}{DkT}\,\frac{\chi}{1+\chi\mathring{a}}} + 2K'\pi$$

Z is the valency, e is the charge of the electron, D the di- constant of the medium, k the Boltzmann constant, T the e temperature, χ^{-1} a characteristic length (sic), å the mini- istance of approach of the ions, and K' a whole number either e or negative; χ^{-1} represents the radius of the ionic atmos- From a physical viewpoint ω represents the relationship n the potential and the thermal energies of a dissociated mole- the electrolyte in solution, i.e., it is an expression of the e energetic states of the molecules in solution. Illustrative es for the application of ω in numerical and graphical calcu- of the solubility are included; the results agree well with the mental data.
A.Avraam

98 THE ISOTOPE EFFECT IN THE ELECTROLYTIC TRANSPORT OF LEAD IONS IN MOLTEN LEAD DE. A.Lundén and G.Blomqvist.

urforsch. (Germany), Vol. 15a, No. 11, 950-2 (Nov., 1960).
man.
periments with an electrolytic pile (graphite cathode / Br_2/LiBr/$PbBr_2$/graphite anode + Br_2) confirmed that the effect (defined as the ratio between the relative difference of mobilities and the relative difference of the mass) is 40% r for lead halides than for other halides. With lead bromide s effect of $\mu = -0.041 \pm 0.006$ was obtained. R.Schnurmann

99 A NOTE ON THE TRANSPORT PHENOMENA OF PURE FUSED NITRATES. A.Lundén.

urforsch. (Germany), Vol. 15a, No. 11, 1019-22 (Nov., 1960).
man.
ith reference to the models proposed by Klemm (Abstr. 8658 0) it appears than an experimental accuracy of a few percent asurement of the electrolytic conductivity, diffusion and ity coefficients is not good enough to pick on one particular as being more representative than the others. More experimental data are required, especially for the diffusion coefficients of some of the alkali halides, for example. R.Schnurmann

15200 THE MOBILITY OF Cd IN THE PYROSOL $CdCl_2$ + Cd. W.Herzog and A.Klemm.

Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1100-7 (Dec., 1960).
In German.

Measurements of ion mobility in molten salts confirmed that the metal dissolved in the salt is present in atomic dispersion. With three types of concentration cells:

1. Cd-anode/$CdCl_2$ + Cd/$CdCl_2$/Cd-cathode,
2. C-anode/$ZnCl_2$/$CdCl_2$ + Cd/$CdCl_2$/$LiCl_2$/C-cathode + Cl_2,
3. Cd-anode/$CdCl_2$ + Cd/Cd-cathode

evidence was obtained of some coupling between the migrating Cd^{++} and Cd. R.Schnurmann

SCRIBE-PLATING AND -ETCHING. See Abstr. 14956

PHOTOCHEMISTRY RADIATION CHEMISTRY

15201 PHOTOELECTROCHEMICAL PROPERTIES OF THALLIUM HALIDES IN THE PRESENCE OF DESENSITIZERS. K.K.Demidov and K.A.Pozihun.

Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 789-92 (1959). In Ukrainian.

Deals with the effect of green pinacryptol on thallium bromide. The results of the investigation show that the photoelectrochemical effect falls when the desensitizer is introduced into the thallium bromide preparation. The effect of desensitization is connected with the surface condition of the crystals.

15202 THE RADIATION INDUCED DECOMPOSITION OF POTASSIUM NITRATE. J.Forten and E.R.Johnson.

J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 218-24 (Oct., 1960).

Measurements of the heats of solutions of irradiated KNO_3 indicate that a transition resembling a lambda transition is induced in the solid at about 1 mol% decomposition. It is believed that this transition can account for the sharp decrease in the decomposition yield which occurs at about 1 mol% decomposition. In addition, evidence is presented which indicates that the mechanism for the decomposition is molecular rather than by means of free radicals or other reactive species.

15203 IONIC POLYMERIZATION OF STYRENE IN METHYLENE DICHLORIDE BY IONIZING RADIATION.

S.Okamura and S.Futami.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 1, 46-51 (May, 1960).

Styrene was polymerized in methylene dichloride (homogeneous phase) by the irradiation of Co^{60} γ-rays at −78° C. The polymerization rate measured is about two hundred times higher than the calculated radical polymerization rate at the same temperature and no oxygen effect is found. Addition of some organic compounds into the polymerization system shows the ionic character of the polymerization mechanism. The rate of polymerization increases proportionally with styrene concentration up to 1.5 mol/l. and has linear dependence on the dose rate. The γ-ray induced copolymerization analysis of a 1 : 1 mixture of styrene and methyl methacrylate and a 3 : 1 mixture of styrene and p-methoxystyrene shows the cationic polymerization mechanism at low temperature. A polymerization mechanism that explains semi-quantitatively the experimental results is proposed.

15204 THE CROSS-LINKING AND CHAIN FRACTURE OF RUBBER BY HIGH-ENERGY RADIATION. P.Hayden.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 65-71 (July, 1960).

Quantitative analysis of the solubility data of irradiated rubber, using the method adopted by Charlesby and Pinner, was applied to the study of the cross-linking reaction. The rate of cross-linking is directly proportional to the radiation intensity and corresponds to a G-value of 0.83 at 25°C. The activation energy of the cross-linking reaction is 0.76 and 0.26 kcal above and below the glass transition temperature, respectively. The ratio of dislinking to cross-linking is 0.05. It is largely independent of radiation intensity and temperature. Radiation induces the formation of some trans-vinylene unsaturation, believed to arise from a double bond shift. A considerable amount of terminal unsaturation, believed to arise as a result of dislinking, is also formed.

15205 DIRECT RADIATION GRAFTING ON TO HYDROPHILIC POLYMERS. A.Chapiro and V.Stannett.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 164-7 (Oct., 1960).

Grafting of vinyl monomers onto films of polyvinylalcohol, Cellophane, cotton, etc. is greatly increased if water is added to the irradiated system. Irradiation of a dry system only leads to surface grafting whereas considerable depth grafting is achieved in the presence of water. The kinetics of the reaction are studied with polyvinyl alcohol films irradiated in styrene solutions in dioxane containing various amounts of water. The results are interpreted on the basis of the increased swelling of the polymer films in the presence of water and agree with independent data derived from sorption isotherms.

15206 RADIOACTIVE ATOMS DISTRIBUTION IN AROMATIC COMPOUNDS LABELLED BY EXPOSURE TO TRITIUM GAS. F.Cacace, A.Guarino, G.Montefinale and E.Possagno.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 82-9 (July, 1960).

The distribution of tritium atoms in chlorobenzene, nitrobenzene and anisole, labelled by contact with tritium gas, was determined. In all the substances examined, ortho and para positions account for about $\frac{2}{3}$ of the radioactivity of the pure tritiated compound. The ratio of activity found in para and meta positions, ranges from 1 : 1 in the chlorobenzene to 1 : 0.6 in the anisole and 1 : 4 in the nitrobenzene, depending on the nature of the substituent groups in the irradiated compound.

15207 SELENIUM OCIDATION IN THE RADIATION FLUX OF A NUCLEAR REACTOR. C.Motoc.
Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 4, 989-97 (1960).
In Roumanian.

The radiation induced oxidation of amorphous and crystalline selenium in bulky form or in thin films on different substrates was investigated. The oxidation occurred at temperatures where thermal oxidation was negligible. With the aid of a metallographic microscope needleshaped SeO_2 microcrystals were observed. The kinetics of selenium oxidation was studied over a period of time.. In order to do it, thin films of selenium, obtained by deposition in vacuum, were enclosed in quartz phials filled with oxygen and were irradiated during different times. No saturation in the oxidation process was observed at a total neutron flux of 6×10^{11} n cm^{-2}. The rate of oxidation, inferred from the slope of the straight line, was 2.9×10^{-4} mg h^{-1}. From the irradiations performed with the aid of γ-rays and fast neutrons in Cd sheets, it was concluded that γ-rays and fast neutrons contribute in the oxidation process.

DISPERSIONS . COLLOIDS

15208 RADIOMETRIC SEDIMENTATION ANALYSIS. R.Lindner, J.O.Liljenzin and H.Reinhardt.
Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1110-12 (Dec., 1960).
In German.

A radiometric sedimentation method is described for the estimation of grain size in α-radiating solids which may be used for very small amounts of material and is of sufficient simplicity for most laboratories. It is suitable for the fissure products of uranium compounds and for the determination of surface adsorption of activated particles by certain oxides (e.g.VO_2), silicates, and glasses. H.H.Hodgson

LIGHT-SCATTERING PROPERTIES OF PIGMENT SUSPENSIONS. See Abstr. 11845

15209 THE TWOFOLD PHYSICAL ASPECT OF THE
INFLUENCE OF DUST DEPOSIT ON THE ELECT
PURIFICATION OF AEROSOLS. M.Pauthenier and R.Cochet
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3204-6 (May 24, 1
In French.

Consideration of a vertical cylindrical precipitation unit
means of a previously developed formula (Cochet and Reffay,
7152 of 1955) indicates how the efficiency of an electro-filter
on both the amount of dust deposited and the consequent count
electrical field developed. H.H.

INVESTIGATIONS ON SUSPENDED PARTICLES IN DIFF
WATER VAPOUR. See Abstr. 11784

THE ANGULAR VARIATION OF LIGHT SCATTERED BY
SINGLE DIOCTYL PHTHALATE AEROSOL DROPLETS.
See Abstr. 11844

EXPERIMENTAL RESULTS RELATING TO THE COALESCENCE OF WATER DROPS WITH WATER SURFACES.
See Abstr. 11745

THE GROWTH OF HYGROSCOPIC DROPS IN A HUMID A
STREAM. See Abstr. 11746

PHYSICAL METHODS OF CHEMICAL ANALYSIS

15210 ASSAY OF $C^{14}O_2$ IN GEIGER COUNTERS.
I.S.Boyce and J.F.Cameron.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4,
(Dec., 1960).

15211 A MASS SPECTROMETER OF HIGH SENSITIVIT
G.Boato, R.Sanna, M.E.Vallauri and M.Reinharz.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 215-31 (1960).
In Italian.

A mass spectrometer particularly suitable for measurin
small variations of the isotopic abundance ratio in light gase
elements was designed and put into operation at the Physics
ment of the University of Genoa. Three instruments, differin
each other in minor details, were built, two of which are in u
the Physics Department in Genoa; the third instrument was h
over to the Laboratory of Nuclear Geology at the University
where it is routinely measuring natural isotopic abundances,
ing paleotemperatures. Details are given of special features
mass spectrometer, which make it different from similar mo
The operating conditions of the instrument are given. The o
sensitivity is about one part over two millions; a precision o
per mil in the measurement of isotopic abundance variations
easily reached in the case of favourable isotopic ratios.

15212 APPLICATION OF THE MAGNETIC PHASE ANA
FOR SEPARATE DETERMINATION OF FREE AN
BOUND CARBON. B.A.Apaev and B.M.Yakovlev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 527-33
(Oct., 1960). In Russian.

A method is described of calculating the quantity of ferro
magnetic phases in heterogeneous systems from the tempera
dependence of intensity of magnetization. The method was us
determine the quantity of cementite in several steels containi
0.2-1.2% C, and to determine the content of free and bound ca
in malleable cast irons. The data obtained were in good agre
with the results of chemical analysis. M.H.

INFRARED ANALYSERS AND THEIR APPLICATION FO
AUTOMATION OF PRODUCTION PROCESSES. See Abstr. 1

GEOPHYSICS

13

ON THE RELATION BETWEEN THE ANOMALOUS REFRACTION AND THE LOCAL Z TERM.

wa.
stron. Soc. Japan, Vol. 12, No. 1, 42-54 (1960).
lining "the local Z term" as the difference between the
ed variation of latitude at the station and that computed from
ect of the polar motion on the selected latitude stars, it is
that: (1) the term varies from one latitude station to
r; (2) the variation is caused by anomalous refraction
ated with a tilting of equi-density air-strata in the free
here; and (3) the anomalous refraction (and hence the local
) undergoes a seasonal fluctuation similar to that of wind
y in the lower atmosphere. The observed annual component
local Z term is due primarily to refraction changes in the
mosphere. D.R.Barber

14

A MODIFICATION OF CAGNIARD'S METHOD FOR SOLVING SEISMIC PULSE PROBLEMS.

Hoop.
sci. Res. B (Netherlands), Vol. 8, No. 4, 349-56 (1960).
modification of Cagniard's method (1939) for solving seismic
problems is given. In order to give a clear picture of
thod, two simple problems are solved: the determination of
alar cylindrical wave generated by an impulsive line source
scalar spherical wave generated by an impulsive point source.

15

THE EARTH'S ELECTRIC FIELD DURING AN ECLIPSE OF THE SUN. G.D.Freier.

phys. Res. (USA), Vol. 65, No. 10, 3179-81 (Oct., 1960).
he earth's electric field was measured during the total
e of the sun on October 2, 1959, and was found to show no
during this period.

16

DIURNAL VARIATION OF EARTH CURRENTS AT THE EQUATOR. R.Hutton and R.W.H.Wright.

os. terrest. Phys. (GB), Vol. 20, No. 2-3, 100-9 (March, 1961).
arth current measurements made at Legon, Ghana (5° 38'N,
W) are analysed for a period of 15 months. From the
is, the mean diurnal variation is found to be 180 mV/km and
rrent direction is shown to be at right angles to the nearby
line. The diurnal variation of earth currents for both quiet
nd disturbed days is given and the effect of the different
s on the quiet day variation is also examined. Good agree-
s found between the shape of the diurnal variation curve for
urrents and the diurnal variation of dZ/dt, the rate of change
vertical component of the earth's magnetic field, and the
lously large value of earth current amplitude is shown on
rison with data for other equatorial stations, to be related to
omalously large daily range of Z which occurs near the
rial electrojet.

17

RADIOACTIVITY ASSOCIATED WITH UNDERGROUND NUCLEAR EXPLOSIONS. R.E.Batzel.

phys. Res. (USA), Vol. 65, No. 9, 2897-902 (Sept., 1960).
he detonation of a contained or partially contained nuclear
ion is accompanied by the deposition of a large fraction of the
in the form of high-temperature, high-pressure regions.
ature of the surrounding medium, the time-temperature
y, and the time of cavity collapse or venting determine the
to which undesirable nuclides such as Sr^{90} and Cs^{137} will
r outside a fused, relatively insoluble matrix and be available
und water or to the atmosphere. The movement of these
irable radioactive nuclides relative to the ground-water
nent can be predicted on the basis of measured K_D'S (distribu-
efficients) for the radioactivities in the medium. The induced
ctivities are a 20 to 25 % contribution to the fission product
ctivity for times of the order of 1 day, and a 1% contribution
nes equal to about 1 week. The contribution decreases to
fter about 45 days, but later, because of the Co^{60} present, it
ses to about 2% for a period of 3 to 15 years.

18

NEW RATE OF ROTATION OF THE EARTH, MEASURED IN JULY 1959. E.Schatzman.

Geophys. (France), Vol. 16, No. 4, 495-506 (1960). In French.
he change of angular momentum of the Earth in July 1959, as found by Danjon [C.R.Acad. Sci. (France), Vol. 250, 1399 (1960)], is of the order of 6.10^{32} g cm^2 sec^{-1}. Several physical phenomena which could possibly lead to such a change of angular momentum are considered. None of these phenomena being acceptable, the capture of solar protons by the Earth's magnetic field is considered. However, the Earth's magnetic field is not strong enough for the capture at large distance from the Earth (60 earth's radii) to occur. The reinforcement of the Earth's magnetic field by the successive formation of two ring currents would allow the capture of a third ring current, at a distance of 100 earth's radii. The angular momentum of that ring would be of the right order of magnitude. However, to reach such a result, it is necessary to suppose that the electric currents are of an exceptionally large intensity. Moreover, the transfer of that angular momentum of the solid Earth is impossible through the magnetic field, and extremely difficult to achieve through viscous friction. Still, the surface wind seems to be too large.

ATMOSPHERE

(Troposphere and Stratosphere)

15219

THE PERFORMANCE OF A GUNN—BELLANI RADIATION INTEGRATOR. J.L.Monteith and G.Szeicz.

Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 91-4 (Jan., 1960).

An alcohol-filled Gunn—Bellani radiation integrator, exposed at Rothamsted from June to December 1958, gave weekly distillation totals that were a linear function of short-wave radiation on a horizontal surface above a limit of 500 cal cm^{-2} week^{-1}. Laboratory experiments with both alcohol- and water-filled models reveal a threshold radiation intensity which can be estimated from the properties of the distilling fluid and the partial pressure of air within the instruments. Distillation is negligible below the threshold, but above, it is proportional to the excess radiation. Because the relation between absorbed heat and radiation incident on a horizontal surface depends on solar altitude and on the proportions of direct and diffuse radiation, it is difficult to predict field response from laboratory data.

15220

THE USE OF THE CAMPBELL—STOKES SUNSHINE RECORDER AS AN INTEGRATING ACTINOMETER.

I.G.Galindo Estrada and E.M.Fournier D'Albe.
Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 270-2 (April, 1960).

A simple method is described to evaluate the daily total direct solar radiation, by measuring the weight of paper burnt in the Campbell—Stokes sunshine recorder.

DETERMINATION OF RAINDROP SIZE DISTRIBUTION USING PHOTOGRAPHIC EMULSIONS. See Abstr. 12853

15221

THE ECONOMICAL NET RADIOMETER. C.B.Tanner, J.A.Businger and P.M.Kuhn.

J. geophys. Res. (USA), Vol. 65, No. 11, 3657-67 (Nov., 1960).

The economical net radiometer of Suomi and Kuhn [Tellus (Sweden), Vol. 10, No. 1, 161-3 (Feb., 1958)] can be used to measure the incoming and outgoing radiation flux density of the total, the solar, and the thermal radiation currents as well as net radiation. This requires at least two radiometers with different spectral absorptions. The theory and errors of the radiometer are developed, and experimental tests of some of the equations are presented.

15222

A VARIABLE ATMOSPHERIC-DENSITY MODEL FROM SATELLITE ACCELERATIONS. L.G.Jacchia.

J. geophys. Res. (USA), Vol. 65, No. 9, 2775-82 (Sept., 1960).

The analysis of satellite accelerations leads to an empirical formula that relates the product

$$\rho H^{1/2} = -\frac{\sqrt{2/\pi}}{3C_D}\,\frac{dP}{dt}\,\frac{m}{AF}\sqrt{\frac{e}{a}}\left[1 - 2e + \frac{5e^2}{2} - \frac{H}{8ae}\left(1 - 10e + \frac{7H}{16ae}\right)\right]$$

(ρ = atmospheric density, H = scale height) to the geometric height z, the 20 cm solar flux F_{20}, and the angular distance ψ' from the centre of the diurnal bulge. Once the numerical parameters of this formula are established, tables of ρ and H are computed and a separate formula is derived to represent ρ in function of the same variables.

15223 CARBON DIOXIDE IN THE ATMOSPHERE AND IN ATLANTIC OCEAN WATER. T.Takahashi.

J. geophys. Res. (USA), Vol. 66, No 2, 477-94 (Feb., 1961).

An investigation of carbon dioxide partial pressures in the atmosphere and surface ocean conducted as part of a cooperative study under the general sponsorship of the I.G.Y. is summarized. Results are given for about 470 hr of air analyses and 200 individual surface ocean water measurements made from 1957 to 1959 between 60°N and 58°S. Over the Atlantic Ocean, the atmospheric carbon dioxide concentration is found to average 316 p.p.m. by volume and to be quite uniform except for a minor increase toward the equator. The total carbon dioxide in the earth's atmosphere is estimated to be 2.41×10^{18} g. In the equatorial region, the partial pressure of carbon dioxide appears to be higher in the surface water than in the atmosphere; in the higher latitudes it appears to be lower.

15224 ATMOSPHERIC TEMPERATURES AND SOLAR ACTIVITY. I. 100 MB IN THE NORTHERN HEMISPHERE AURORAL ZONE. F.W.Ward, Jr.

J. Meteorol. (USA), Vol. 17, No. 2, 130-4 (April, 1960).

An attempt is made to determine whether there are systematic temperature changes in or near the Northern Hemisphere auroral zone at 100 mb due to anomalous solar corpuscular radiation. A number of tests is conducted yeilding generally negative results. The one possible exception is a test indicating a temperature rise of approximately 1 deg C following magnetic storms which were preceded by at least one week of relatively undisturbed (geomagnetically) conditions. The usual significance tests show the increase to be significant above the five-per-cent level. However, the results of other tests do not tend to confirm this result, and hence there is some doubt as to its reality. In any event, an upper limit of approximately 1 deg C is indicated as the largest average systematic rise to be expected at 100 mb from solar corpuscular storms.

15225 ON INDIRECT TEMPERATURE SOUNDINGS OF THE STRATOSPHERE FROM SATELLITES. D.Q.Wark.

J. geophys. Res. (USA), Vol. 66, No. 1, 77-82 (Jan., 1961).

Outgoing radiation from the atmosphere is calculated at several frequencies in the 15-μ carbon dioxide band according to the random Elsasser band model and the Curtis—Godson approximation to the mean line width. From the resulting values, an inversion of the problem is performed, with simplifying assumptions, to recover the temperature structure of the upper part of the atmosphere. This abbreviation of the experiment proposed by Kaplan (1956) would yield the temperatures and the lapse rates in two layers of the atmosphere from three measurements of the outgoing radiation. Results from three model atmospheres indicate that calculated mean lapse rates and mean temperatures in the two layers, as they might be deduced from measurements made from a satellite, are in good agreement with actual temperature structures.

15226 WATER VAPOR DISTRIBUTION ABOVE 90 000 FEET D.G.Murcray, F.H.Murcray, W.J.Williams and F.E.Leslie.

J. geophys. Res. (USA), Vol. 65, No. 11, 3641-9 (Nov., 1960).

The absorptions due to the 6.3 μ band of water vapour were measured for altitudes up to 92 000 ft. On the basis of these absorptions the humidity mixing ratio for the region above 92 000 ft is calculated, the calculated values ranging from 1.5×10^{-4} g/g to 3.4×10^{-4} g/g. The mixing ratio from 40 000 to 92 000 ft was also calculated, yielding values at least an order of magnitude lower than the values obtained above 92 000 ft. It is concluded that at least 20 μ of precipitable water was present above 92 000 ft over Alamogordo, New Mexico, on June 19, 1959.

15227 THE STRUCTURE OF ATMOSPHERIC TURBULENCE. A.S.Monin.

Teor. Veroyatnost. i Primenen., Vol. 3, 285-317 (1958).
In Russian, with English summary.

This is an account of experimental and theoretical work on the structure of the turbulence in the earth's boundary layer. The layer is assumed to be in a condition of horizontal homogeneity and transferring constant shear stress and constant flux of total heat. It is therefore specified by the these quantities and the characteristic length

$$L = -\frac{\tau^{3/2}}{\kappa(g/T_0)(Q/\rho c_p)}$$

Experimental measurements of mean velocity distributions are good agreement with the dimensional consequences of the speci cation for upward and downward heat fluxes. Also considered a the magnitudes of the turbulent velocity fluctuations and the bal between their production,. transport and dissipation, and the tem perature fluctuations and their balance. The correlations and spectra of the fluctuations within the Kolmogoroff range of simi rity are described, and the theory of the space and time spectra in the inertial sub-range is treated in some detail. A short summary is given of work relating to pressure fluctuations, par accelerations, turbulent diffusion and to the production of waves

Mathematical Reviews (A.A.Town

15228 FIRST INVESTIGATION ON CLOUDS OVER BRITIS ISLES USING AN AIRCRAFT. J.Mazur.

Acta phys. Polon. (Poland), Vol. 20, No. 2, 141-55 (1961).

The danger of ice formation to aircraft led to a number of experiments in which ice is produced artificially under controll conditions of temperature, airspeed, size and number of suspen water particles. The applications of the results of such experiments depend on information about the number and size distribu of water particles in natural clouds. In order to get such inforr ation the author (on the behalf of the Air Ministry, Meteorologic Research Committee), carried out during the war investigations all types of clouds and fogs over the British Isles (Fog Investigation and Dispersal Operation, better known as FIDO).

15229 ELECTRIC FIELD BELOW CLOUD. S.Saga and T.Ogawa.

J. Geomagn. Geoelect. (Japan), Vol. 12, No. 3, 138-47 (1961).

On the question of the charge on rain drops, there occurs t serious problem of the electric field below cloud, due to the discrepancy between the Altielectrograph results of Simpson an Scrase, and Simpson and Robinson, and the theoretical calculati by Whipple and Scrase on the basis of Wilson's space-charge th Taking the lifetime of small ions into consideration, it was foun that there is the possibility of rapid increase of the field intens below the height of 100 m; the magnitude at that level is about t times as large as that at the earth's surface. This rapid increa may have caused the erroneous estimation of the coefficient in relation between the electric current through the sounding appa and the field intensity used by Simpson and Scrase, and so the a discrepancy may have arisen.

CELLULAR STREAM MOTION IN CLOUDS.
See Abstr. 12850

15230 ATMOSPHERIC NET RADIATION FLUX DURING WINTER IN THE THULE AREA, GREENLAND.

R.W.Fenn and H.K.Weickmann.

J. geophys. Res. (USA), Vol. 65, No. 11, 3651-6 (Nov., 1960).

A brief description an airborne infrared net radiation rece (developed in Germany) is given, and the results of radiosonde flights made with this element at Thule, Greenland, during Feb 1959 are shown. The outgoing net radiation flux during the arc winter increases with altitude from 0.05 cal cm^{-2} min^{-1} at the face to about 0.2 cal cm^{-2} min^{-1} between 15 000 and 20 000 metr Above 25 000 metres the outgoing net radiation flux again decre considerably.

15231 SOLAR RADIATION AT UCCLE. M.Nicolet.

Publ. Inst. Roy. Meteorol. Belgique A, No. 18, 60 pp. (1961).
In French.

The first of 10 annual reports summarizing the results of insolation, and radiometric observations made at the Uccle met ological station in 1951-1960. Five separate tables give for ea hour of day, and day of month in each month of the year, values the following parameters: duration of insolation, as measured (i) a Campbell—Stokes sunshine recorder, and (ii) a standard ty of solar actinometer; the incident direct solar radiation; the to solar radiation; and the diffuse (sun + sky) radiation incident or horizontal surface. All data are reduced to the International Pyrheliometric Scale of 1956. The present report presents the for 1959.

D.R.B

32 MEASUREMENT OF THE ALBEDO OF LARGE AREAS FROM AN AIRPLANE. N.I.Hoisa.

n fiz. Zh. (USSR), Vol. 4, No. 6, 793-802 (1959). In Ukrainian.
esults are presented of the measurement of the albedo of
areas in the basic landscape zones of the Ukraine. The
rements were made at altitudes of 200 and 1000 m by means
Janiszewski pyranometers and a portable type PP direct-
nt potentiometer. Two series of measurements were made —
the summer and autumn of 1958. The result obtained was that
e great variations in the albedo of individual areas, each
ape zone is distinguished by its own reflective capacity.
the albedo in summer of the forest zone is 18.8%; of the
-steppe zone, 20.4%; of the steppe zone, 17.0%. The repetition
tain albedo values is also typical for each landscape zone.
stribution curve of repetition of the albedo for the forest
as two maxima corresponding to albedos of 13.5 and 19.5%
ctively. For the forest-steppe zones, these curves have one
um each. The number of maxima and their acuteness is
nined by the "spottiness" of the surface. Data from observa-
onducted in 1952-1953 and in 1958 furnished a basis for
nining the seasonal change characteristics in the forest zone
(for spring, summer and autumn).

IGHT SCATTERING BY INHOMOGENEOUS ATMOSPHERES.
bstr. 12829

IGHT SCATTERING BY A SEMI-INFINITE ATMOSPHERE.
ostr. 12830

N THE RELATION BETWEEN THE ANOMALOUS REFRAC- AND THE LOCAL Z TERM. See Abstr. 15213

233 AN IMPROVED TECHNIQUE FOR OBTAINING ATMOSPHERIC ION MOBILITY DISTRIBUTIONS.

hipple, Jr.
phys. Res. (USA), Vol. 65, No. 11, 3679-84 (Nov., 1960).
n improved technique for obtaining atmospheric ion mobility
butions using Blackwood's double-electrode condenser is
ibed, which simplifies both the experimental procedure and the
nalysis. Only the current to the second electrode needs to be
red, and it is shown that the mobility distribution can be
ed with one rather than two differentiations of the character-
urve. Two representative small-ion distributions with good
tion, obtained with this technique, are presented and discussed.

34 MEASUREMENTS OF SPACE CHARGE IN THE LOWER ATMOSPHERE USING DOUBLE FIELD MILLS.

iddy and J.A.Chalmers.
J. Roy. Meteorol. Soc. (GB), Vol. 86, 79-84 (Jan., 1960).
wo double field mills (Smiddy and Chalmers 1958) were used
dy space charge in the lowest 5 m of the atmosphere. Results
r weather show small values, often negative, which can be
ined in terms of radioactivity of the ground. Comparison
esults from filtration apparatus suggest that the latter may
error when small ions are present in large numbers. Results
ht or moderate rain show small space charges, but in heavy
negative space charges of the order of $-1000\ \mu\mu c\ m^{-3}$ are
, probably formed by splashing. In snowfall, there are charges
h signs of about ± 500 $\mu\mu c\ m^{-3}$.

235 POINT-DISCHARGE CURRENTS FROM NATURAL AND ARTIFICIAL POINTS. J.E.Maund and J.A.Chalmers.

J. Roy. Meteorol. Soc. (GB), Vol. 86, 85-90 (Jan., 1960).
When point discharge occurs at an earth-connected point, ions
sign travel to earth through the point while ions of opposite
travel away in the wind. This stream of ions reduces the
tial gradient at the ground to leeward of the point below that
ndward. Theory shows that, under suitable conditions, this
ence in potential gradient is close to that predicted for a line
arge, even though the line is spread into a cone by turbulent
ion. Measurements with point discharge from a 34 m mast
good agreement with theory, and this makes it possible to use
ifference of potential gradient to determine the point-discharge
nt through a tree. When applied to a line of trees, seasonal
ences are found suggesting smaller currents from trees in
han from bare trees. Measurements with a 12 m sycamore
in full leaf show no point-discharge current even in potential
ents up to 7000 V/m.

15236 A NOTE TO THE PAPER BY C.B.MOORE, B.VONNEGUT, B.A.STEIN AND H.J.SURVILAS "OBSERVATIONS OF ELECTRIFICATION AND LIGHTNING IN WARM CLOUDS". L.Alpert.

J. geophys. Res. (USA), Vol. 66, No. 1, 332 (Jan., 1961).

See Abstr. 16485 of 1960. In support of the view that intense electrification responsible for lightning in warm clouds, all parts of which are above $0^\circ C$, is not confined to tropical and subtropical latitudes a quotation is given from a report by Marchand in 1903. He observed rain falling from clouds lying wholly between Bagneres (547 m) and Pic du Midi (2866 m) and with all levels above $0^\circ C$. Thunder was heard from these clouds on some occasions.

R.S.Read

15237 SFERICS FROM INTRACLOUD LIGHTNING STROKES. L.R.Tepley.

J. geophys. Res. (USA), Vol. 66, No. 1, 111-23 (Jan., 1961).

It is well known that cloud-to-ground lightning strokes are prolific sources of very low frequency (VLF) sferics. The contributions of other types of discharges, however, have been largely ignored in the literature. This paper shows that intracloud lightning strokes also radiate significant energy at both very low frequencies and extremely low frequencies (ELF). This conclusion is based primarily on the experimental observation that most ELF sferics (slow tails) are of negative polarity. From a study of a number of possible mechanisms for generating negative slow tails, the following conclusions were made: (1) only the intracloud stroke (specifically, the element of the discharge frequently referred to as the "K change") is likely to be statistically important; (2) intracloud strokes also radiate significant VLF energy; (3) the properties of ELF sferics are uniquely suited for the study of the electrical "fine structure" of thunderstorms at many thousands of kilometers under night-time conditions.

15238 WHISTLER DISPERSION AND EXOSPHERIC HYDROGEN IONS. R.E.Barrington and T.Nishizaki.

J. geophys. Res. (USA), Vol. 65, No. 9, 2581-2 (Sept., 1960).

Accurate measurements show that the variation of whistler dispersion with frequency is of the form predicted by Storey (1956) for an exosphere consisting largely of ionized hydrogen. From these measurements the height at which protons become sufficiently numerous to affect the whistler dispersion is estimated to be 1000 km.

15239 TRAVELING WAVE AMPLIFICATION OF WHISTLERS. N.M.Brice.

J. geophys. Res. (USA), Vol. 65, No. 11, 3840-2 (Nov., 1960).

Following previous work the amplification of an e.m. wave by an electron stream using travelling wave tube theory is considered. Bunching tends to occur at the point where the field passes through zero from acceleration to deceleration and, if the particle velocity exceeds that of the wave, amplification occurs. It is shown that in a homogeneous medium any trapped particles may amplify the wave. The theory can also explain the increase in amplitude of the first few whistlers in a train.

D.Llanwyn-Jones

15240 CLIMATIC CHARTS AND DATA OF THE RADIO REFRACTIVE INDEX FOR THE UNITED STATES AND THE WORLD. B.R.Bean, J.D.Horn and A.M.Ozanich,Jr.

Nat. Bur. Stand. (USA), Monogr. No. 22, 178 pp. (1960).

The radio refractive index of air, $n = 1 + N \times 10^{-6}$, is a function of atmospheric pressure, temperature, and humidity and varies in a systematic fashion with climate. The refractive index data listings given are made up of observations from 45 US surface weather stations for 2-hour intervals over an 8-year period. Mean values, maxima, minima, and standard deviations of the refractive index are calculated and tabulated for these observations. Additionally, mean vertical profiles of the refractive index have been prepared for 43 US upper air sounding stations from long-term means of pressure, temperature, and humidity. Earlier studies of refractive index climate are assimilated and put into perspective. One such study is an extensive analysis and mapping of the refractive index climate of the United States. A worldwide radio refractive index climatology is developed based upon monthly mean observations of pressure, temperature, and humidity. An important finding of these climatological investigations is the strong correlation of N with height. A reduced-to-sea-level value of the index, termed N_0, is used to eliminate this systematic height dependence. The surface value of N, N_S, may be estimated four to five times more accurately from charts of N_0 than from similar-sized charts of N_S itself. From climatic charts of N_0, N_S may be estimated at any given location in the United States throughout the day during every season. In addition detailed annual and diurnal cycles, as well as 8-year cumulative probability distributions, are given for 12 representative US stations. On a worldwide basis, charts of mean N_0 are presented for both summer and winter season.

15241 THE EFFECT ON MAN OF LOW FREQUENCY ELECTRICAL PROCESSES IN THE ATMOSPHERE.

H.König and F.Ankermuller.

Naturwissenschaften (Germany), Vol. 47, No. 21, 486-90 (Nov., 1960). In German.

Atmospherics in the frequency range 1 to 25 c/s can be classified into 5 or 6 types according to the form of the constituent oscillations and the regularity and amplitude of the wave trains. The reaction times of several thousand people were measured when two of those types of atmospheric predominated. The average reaction time changed in opposite directions according to the type, and the same sense of change was observed when experiments were conducted in conditions which reproduced artificially the two types of atmospheric. The significance of the effect and its possible relation with other similar effects are briefly discussed. J.M.Stagg

15242 A CONTINUOUS DOSAGE SYSTEM FOR RADON IN ATMOSPHERIC AIR. APPLICATION TO URANIUM PROSPECTING.

D.Blanc, J.Fontan and G.Vedrenne.

J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 176A-180A (Nov., 1960). In French.

A very powerful pump sucks the air being analysed through a paper filter, the efficiency of which is great enough to eliminate all radioactive particles in the aspirated volume. Any excessive charge loss can be avoided by the use of large surface filters in series. The air then goes into a leakproof disintegration chamber the capacity of which is several hundred litres. Part of the radon content is disintegrated in it; when leaving the chamber, the particles of radioactive products are collected by another paper filter having a great efficiency. The alpha activity of the filter is continuously measured with an integrator and a graphic meter. The device makes possible the dosage of radon concentration of 2×10^{-14} curie per litre. A "Babar" type apparatus can be added to the previous device: it permits measurement of the activity of the radioactive products of radon in air; the air passes through filter paper which unwinds before a photomultiplier and such is the unwinding speed that activity due to the radioactive products of thoron is negligible, time not being sufficient for the establishment of equilibrium. These devices, used together, allow a simultaneous registering of the activity of radon and its radioactive products. The ratio between both activities is a function of the time at which the radon has been emitted from the ground; knowing wind direction and speed, localization of uranium deposits are possible. This method is suitable for remote prospecting in regions difficult of access.

15243 DETECTION AND DOSIMETRY OF NATURAL ATMOSPHERIC RADIOACTIVITY.

D.Blanc, J.Fontan, R.Soulhier and G.Vedrenne.

J. Phys. Radium (France), Vol. 22, No. 1, 50-9 (Jan., 1961). In French.

The nature of natural atmospheric radioactivity is recalled and the various methods of detection and dosimetry of this radioactivity surveyed, including direct methods (ionization chamber, proportional counter, scintillator) and indirect methods (thermal, centrifugal and electrostatic precipitations, filtration). Taking into account the diffusion of emanation and the meteorological conditions that modify the natural radioactivity of air, the order of magnitude of this radioactivity is estimated.

15244 OBSERVATIONS OF THE TEMPORARY PRESENCE OF RADIOACTIVE MATTER IN THE ATMOSPHERE.

C.D.Anger and R.R.Brown.

J. geophys. Res. (USA), Vol. 65, No. 10, 3502-3 (Oct., 1960).

Reports the results of a series of cosmic ray balloon flights which took place in late 1958. A lead-shielded Geiger counter was carried in the balloon. Radiation well above the normal cosmic level was recorded on two occasions for heights exceeding 12 km. The observations are attributed to radioactive layers in the atmosphere (resulting from nuclear explosions) at heights of at least 60 km and 85 km. D.Llanwyn-Jones

15245 BALLOON OBSERVATION OF ARTIFICIAL RADIO-ACTIVITY AT THE BASE OF THE STRATOSPHERE.

H.T.Mantis and J.R.Winckler.

J. geophys. Res. (USA), Vol. 65, No. 11, 3515-19 (Nov., 1960).

On two ascents of a series of IGY cosmic-ray balloon flights, layers of radioactivity were observed near the tropopause at Minneapolis, Minnesota. On March 21, 1958, a specific activity 0.8×10^{-5} disintegrations cm^{-3} sec^{-1} was observed and on Octobe 1958, the value was 0.4×10^{-5}. Upper-air trajectories were constructed for the events, and these, together with the mean energy, specific activity, and vertical profiles of the radiation, consistent with the hypothesis that this radioactivity was produc by Soviet nuclear bomb debris about 1 week old.

15246 RADON FLUX AT THE EARTH—AIR INTERFACE.

M.H.Wilkening and J.E.Hand.

J. geophys. Res. (USA), Vol. 65, No. 10, 3367-70 (Oct., 1960).

A radon condenser utilizing a trap cooled by liquid oxygen used to measure the radon content of the atmosphere and of the soil gases escaping through the surface of the earth. The avera atmospheric-radon concentration at ground level in the Socorro area was found to be 0.24×10^{-12} curie l^{-1} and a measurement the radon flux at the earth—air interface gave a result of 90 × curie cm^{-2} sec^{-1}. The radon content of the air showed a diurn fluctuation, whereas the radon flux at the earth—air interface appeared to be relatively constant over a diurnal period. Diffus theory is used to derive an expression for the radon flux in terr of the concentration of radon in the soil at depth. The flux valu measured is consistent with a concentration of radon produced 1.1×10^{-12} gm of radium per gm of soil.

15247 THE ATTACHMENT OF THE DECAY PRODUCTS O RADON AND THORON TO ELECTRICALLY CHARG AEROSOL PARTICLES.

L.Lassen.

Z. Phys. (Germany), Vol. 163, No. 4, 363-76 (1961). In Germar

In a previous paper (Abstr. 628 of 1961), an equation was derived for the attachment of the decay products of radon and th to aerosol particles, considering the deposition to be solely governed by thermal diffusion. As most aerosols in nature are electrically charged it is shown how the diffusion process is mo fied by the influence of electrostatic forces between diffusing io and charged aerosol particles. For the frequently occurring ca a symmetrically bipolar charged aerosol and ion diffusion it is further shown that the attached activity is proportional to

$$\frac{R^2F(R,x)}{(1 + hR)}$$

where x depends on the electrostatic charge and the radius of t aerosol particles. Applying this equation to the deposition of nat radioactivity on atmospheric aerosols, and assuming that partic size distribution can be roughly approximated by a law $N(R) = \text{const.}\ R^{-3}$ in the range $10^{-6} \leq R \leq 10^{-3}$ cm, calculation s that 90% to 95% of the total natural radioactivity should be attac to particles smaller than $R = 5 \times 10^{-5}$ cm and as much as 50% t to particles smaller than $R = 5 \times 10^{-6}$ cm. It is concluded that distribution of natural radioactivity on the different particle siz atmospheric and artificial aerosols is fundamentally dependent the diffusion process, including ionic diffusion.

RESULTS OF THREE-YEAR SYSTEMATIC MEASUREMEN NUCLEAR FALL-OUT. See Abstr. 13678

15248 INVESTIGATION OF THE FREQUENCY SPECTRA AMPLITUDE AND PHASE DIFFERENCE FLUCTUA TIONS OF SOUND WAVES IN A TURBULENT ATMOSPHERE.

G.S.Golitsyn, A.S.Gurvich and V.I.Tatarskii.

Akust. Zh. (USSR), Vol. 6, No. 2, 187-97 (1960). In Russian.

Presents the results of an experimental investigation of the frequency spectra of amplitude and phase difference fluctuation sound propagated in the layer of atmosphere near the surface of the earth. Comparison of the results of the measurements with theory, the latter based on Kolmogorov's turbulence scheme, le to satisfactory agreement. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 185-94 (Oct.,-Dec., 19

15249 INFRASONIC NORMAL MODES IN THE ATMOSPHE

Yu. L. Gazaryan.

Akust. Zh. (USSR), Vol. 7, No. 1, 26-32 (1961). In Russian.

The results are given from numerical calculation of the characteristics of normal modes with periods greater than one minute for models of the atmosphere with one and two temperat minima. [English translation in: Soviet Physics—Acoustics (U Vol. 7, No. 1, 17-22 (July-Sept., 1961)].

SOUND PROPAGATION OVER OCEAN WATERS IN FOG. See Abstr. 12942

UPPER ATMOSPHERE
IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

:50 GEOMAGNETIC, AURORAL, IONOSPHERE AND COSMIC
RAY DISTURBANCES: INTERDEPENDENCE AND
TION WITH SOLAR ACTIVITY. F.Mariani and F.Molina.
eofis. (Italy), Vol. 13, No. 2, 135-230 (April-June, 1960).
ian.

251 CATALOGUE OF DISTURBANCES IN IONOSPHERE,
GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO
, COSMIC RAY, SOLAR PHENOMENA AND OTHER
TED PHENOMENA.
onosphere Space Res. Japan, Vol. 14, No. 1, 73-131 (March,

atalogue No. 35. Results are given of simultaneous observa-
of the disturbances during the periods July 10 to 11 and July
19, 1959.

252 CATALOGUE OF DISTURBANCES IN IONOSPHERE,
GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO
, COSMIC RAY SOLAR PHENOMENA AND OTHER RELATED
OMENA.
Ionosphere Space Res. Japan, Vol. 14, No. 3, 321-83
, 1960).
atalogue No. 37. Results are given for the period 29 March
pril, 1960.

253 ON THE PHYSICAL PROPERTIES AND COMPOSITION
OF THE UPPER ATMOSPHERE BETWEEN 100 AND
ILOMETRES ABOVE GROUND IN MIDDLE LATITUDES.
ezawa.
dio Res. Lab. (Japan), Vol. 7, 69-84 (March, 1960).
he number densities of atomic and molecular oxygen and
ular nitrogen as well as the temperatures, densities, pressures,
heights and mean molecular weights of the upper atmosphere
en the 100 and 400 km levels in middle latitudes were computed
method of trial and error so that the calculated densities fit
sely as possible to those deduced from observations of orbital
es of artificial earth satellites. The results show a substantial
ment with those of other workers, e.g. within the factor of 1.5
ding a very few exceptional cases in the case of atmospheric
ty, and in this case the curve representing the author's atmos-
ic densities runs midway among those of other workers so that
esent results may be taken to be approximately correct.

254 REACTIVITY OF SODIUM AND OF LITHIUM IN THE
UPPER ATMOSPHERE.
mont, M.L.Lory and G.Courtès.
Geophys. (France), Vol. 16, No. 4, 435-44 (1960). In French.
Determination of the time constant of disappearance of
m and lithium at the altitude of 190 km from the D_2/D_1 ratio
resonance lines emitted by man-made alkali clouds.

255 A TEST OF A PROCEDURE FOR EASY ESTIMATION
OF REPRESENTATIVE MONTHLY ELECTRON
SITY PROFILES FOR THE IONOSPHERE. J.W.Wright.
ophys. Res. (USA), Vol. 65, No. 10, 3215-17 (Oct., 1960).
A recently proposed method for obtaining a representative
hly electron-density profile for a given hour of the day applies
lard N(h) procedures to a single representative virtual-height
obtained in a special way from the individual daily virtual-
t curves for that hour. The method is tested by comparing
ples of the resulting profile with the average of the profiles
e individual days. The differences are small compared with
ispersion of the individual profiles about their mean. It is
luded that the method is valuable for obtaining a world-wide
morphology with a minimum expenditure of effort.

256 HYDROMAGNETIC WAVES IN THE IONOSPHERE.
W.E.Francis and R.Karplus.
phys. Res. (USA), Vol. 65, No. 11, 3593-3600 (Nov., 1960).
A numerical integration of the hydromagnetic wave equations in
nosphere is carried out. Tables and graphs are given for the
ions between the field amplitudes above and below the ionosphere
and for the power dissipated as a function of altitude. The case of a vertically incident plane monochromatic wave near 45° geomagnetic latitude is treated. The results are used to confirm earlier estimates of ionospheric heating by hydromagnetic waves and to estimate the transit time of extremely low-frequency signals.

15257 AN APPROXIMATE METHOD OF ESTIMATING THE SIZE AND SHAPE OF THE STATIONARY HOLLOW CARVED OUT IN A NEUTRAL IONIZED STREAM OF CORPUSCLES IMPINGING ON THE GEOMAGNETIC FIELD. V.C.A.Ferraro.
J. geophys. Res. (USA), Vol. 65, No. 12, 3951-3 (Dec., 1960).

Using a formula derived by the author [Ibid. Vol. 57, 15-49 (1952)] an approximate method is developed for estimating the size and shape of the stationary hollow carved out when a solar corpuscular stream impinges on the geomagnetic field. It is also shown that in a two-dimensional magnetic field, the breadth of the hollow at infinity is finite and is given by

$$(2\pi I^2/\rho v^2)^{1/2}$$

where I is the current flowing in a permanent inducing system, ρ the density, and v the velocity of the stream.

15258 THE DETERMINATION OF IONOSPHERIC ELECTRON CONTENT FROM SATELLITE DOPPLER MEASUREMENTS. I. METHOD OF ANALYSIS. W.J.Ross.
J. geophys. Res. (USA), Vol. 65, No. 9, 2601-6 (Sept., 1960).

A procedure for determining the ionospheric electron content up to the height of an active satellite from Doppler data is developed. The equations derived from first-order theory are discussed and corrected separately for earth curvature, large refraction, off-zenith orbit, vertical satellite motion, horizontal ionosphere variations, and the effects of the earth's magnetic field. The methods were developed initially for use with the harmonic radiations from satellite $1958\delta_2$ at frequencies of approximately 20 and 40 Mc/s, but may be adapted to other harmonic frequency ranges. The results obtained by applying this method to the experimental data from $1958\delta_2$ are presented in part 2. See following abstract.

15259 THE DETERMINATION OF IONOSPHERIC ELECTRON CONTENT WITH SATELLITE DOPPLER MEASUREMENTS. II. EXPERIMENTAL RESULTS. W.J.Ross.
J. geophys. Res. (USA), Vol. 65, No. 9, 2607-15 (Sept., 1960).

The preliminary results of the analysis of daytime Doppler frequency records from satellite $1958\delta_2$ for the period September 1958 to December 1959 are presented in the form of ionospheric electron content derived using the methods of part 1. Strong seasonal effects are found, the content being lower and the equivalent slab thickness greater in summer than in winter. Magnetic control of the summer ionosphere content is indicated, although the equivalent slab thickness is almost constant. The values of content obtained agree fairly well with the results of independent polarization rotation studies.

15260 THE ELECTRON CONTENT OF THE IONOSPHERE IN WINTER. J.V.Evans and G.N.Taylor.
Proc. Roy. Soc. A (GB), Vol. 263, No. 1313, 189-211 (1961).

Observations at two closely spaced frequencies of the Faraday rotation of moon-reflected radio waves are described. These measurements have provided accurate values for the total electron content of the ionosphere for many hours on successive days. The observations reported here span a period of one month during the winter of 1960. Short-period fluctiations of the total electron content were observed. These were of about 2 to 3% in amplitude and occurred chiefly during the day-time. The gross shape of the F2 region as determined by the ratio of the number of electrons above the F2 peak to the number below was roughly constant during the day, but showed a wide scatter of values at night. The scale height of the ionizable constituent at the F2 peak was found to be about the same as that of the neutral particles during the day, indicating almost complete mixing. At night, the scale height of the ionizable constituent appeared to increase with the planetary magnetic index K_p. It is not possible to say if this was the result of heating of the region or the consequence of electrodynamic drifts.

15261 DOPPLER SHIFTS AND FARADAY ROTATION OF RADIO SIGNALS IN A TIME-VARYING, INHOMOGENEOUS IONOSPHERE. I. SINGLE SIGNAL CASE. J.M.Kelso.
J. geophys. Res. (USA), Vol. 65, No. 12, 3909-14 (Dec., 1960).

Equations are derived for the frequency shift of a radio signal transmitted to the ground from a space vehicle in or above the ionosphere. The principal restriction on the generality of the results is that the ionosphere is treated as quasi-isotropic; i.e., the ray paths are obtained by methods which would be exact in a slowly varying isotropic medium, but the refractive index is permitted to be a function of ray direction (implying an anisotropic ionosphere). The following conditions prevail: (a) the (slowly varying) ionosphere may be a general function of three spatial coordinates and of time; (b) the vehicle may follow an arbitrary (nonrelativistic) trajectory; (c) the magnetic field, which characterizes the dependence of the refractive index on direction, may have arbitrary form.

15262 IONOSPHERIC ABSORPTION AT TIMES OF AURORAL AND MAGNETIC PULSATIONS.

W.H.Campbell and H.Leinbach.

J. geophys. Res. (USA), Vol. 66, No. 1, 25-34 (Jan., 1961).

A study in March and April, 1960, showed variations in the auroral zone ionospheric absorption of cosmic noise to be closely related to magnetic field micropulsations and short period coruscations of λ 3914. At times of polar-cap type absorption, magnetic micropulsation amplitudes were diminished. Auroral ionization in the E region, estimated from a particular luminosity-height profile, accounted for 50%, at least, of the cosmic noise absorption.

15263 USE OF THE INCOHERENT SCATTER TECHNIQUE TO OBTAIN IONOSPHERIC TEMPERATURES.

T.E.VanZandt and K.L.Bowles.

J. geophys. Res. (USA), Vol. 65, No. 9, 2627-8 (Sept., 1960).

If the ion—electron gas is in diffusive equilibrium on the topside of the F layer, then the electron density decreases exponentially with height, and its logarithmic decrement is proportional to the neutral gas temperature. From an electron density profile obtained by the scatter radar technique, it is shown that this interpretation is consistent. Moreover, the deduction of ionospheric temperatures in this way from scatter radar electron density profiles has several advantages over other methods.

15264 SPACED OBSERVATIONS OF THE LOW-FREQUENCY RADIATION FROM THE EARTH'S UPPER ATMOSPHERE. G.R.A.Ellis.

J. geophys. Res. (USA), Vol. 66, No. 1, 19-23 (Jan., 1961).

Observations of 5 kc/s radio noise with a network of four stations extending across southern Australia are described. It is shown that there is often good correlation of the amplitude variations over a distance of 3000 km and that the observed amplitude differences may be explained by assuming that the radiation propagates in the earth—ionosphere wave guide from geographically large sources. Some discrete sources were observed.

15265 ANALYTICAL CONSIDERATIONS OF IONOSPHERIC WINDOWS FOR LOW FREQUENCY RADIO WAVES.

J.Heading.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 1, 31-9 (Feb., 1961).

After a brief consideration of an isotropic ionosphere, the reflection coefficients for anisotropic ionospheres with free space below and above are examined for their zeros. The particular case studied corresponds to vertical propagation in an Epstein distribution of ionization density together with a vertical magnetic field. In this case it is found that zeros are possible only for one particular polarized wave in the absence of a collision frequency, and the results are illustrated with reference to numerical data from a physical ionosphere.

15266 STATISTICAL ANALYSIS OF RADIO STAR SCINTILLATION. S.Gruber.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 1, 59-71 (Feb., 1961).

Radio star scintillation data are analysed by statistical techniques to find the autocorrelation functions and power density spectra of the fluctuations in amplitude and phase. Interpretation is given in terms of a drifting phase-changing screen as postulated by Booker, Ratcliffe and Shinn. It is shown how the drift velocity of the irregularities in ionospheric electron density that lead to the scintillations, as well as the mean square amplitude and phase of the fluctuations, may be obtained from these records.

15267 VERTICAL DISTRIBUTION OF RADIO REFRACTIVE INDEX IN THE MEDIUM HEIGHT OF ATMOSPHERE.

K.Tao and K.Hirao.

J. Radio Res. Lab. (Japan), Vol. 7, 85-93 (March, 1960).

The mean vertical distribution of the refractive index is studied by the use of the various kinds of data. Though the distribution in the lower part of the atmosphere well agrees with the form of an exponential curve, the upper part is not to be expressed by the polation of this formula. Further, a new method available for check of stability of the mean distribution curve is introduced some examples obtained of the data in Japan.

15268 ON THE OBSERVATIONAL RESULTS OF f_{min} AT YAMAGAWA. S.Ishikawa and K.Muramatsu.

J. Radio Res. Lab. (Japan), Vol. 7, 405-8 (July, 1960).

Since little is known with regard to f_{min} at night-time, du the lower limit of frequency of the standard ionosonde being to high to measure the night value of f_{min} without interference, measurements were made at Yamagawa by shifting the lower l of frequency of the ionosonde from 1.0 Mc/s to 0.5 Mc/s.

15269 THE ANALYSIS OF NIGHT-TIME h'(f) RECORDS. T.Titheridge.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 209-12 (March, 1961).

15270 IONOSPHERIC DISTURBANCES FOLLOWING A SO FLARE. G.E.Hill.

J. geophys. Res. (USA), Vol. 65, No. 10, 3183-3207 (Oct., 1960).

Northern hemispheric charts of f_{min}, f_oE_s, and f_oF_2 at intervals of 3 hr were constructed for the disturbed period fro September 12th to 15th, 1957. Enhanced f_{min} values were fou over the polar cap on September 12. By the time of the sudden commencement (SC) of geomagnetic activity (0046Z, September the f_{min} disturbance spread outward to the auroral zone. Follo the SC, the f_{min} disturbance formed in an elliptical ring around earth while the polar-cap f_{min} disturbance dissipated. The elli ring (coincident with constant dip lines) then expanded southwar and by 0900Z, the approximate time of the main phase, the f_{min} disturbance reached a constant dip of about 72°. Just to the no of this ring, in Canada, a crescent-shaped sporadic-E disturba developed. It also moved southward. Subsequently, a band of sporadic E appeared over northern Asia. The f_oF_2 disturbance began about the time of the SC and lasted about 36 hr. On the b of the f_{min} and f_oE_s patterns, it is concluded that, prior to the solar corpuscles impinge on the lower ionosphere directly from outside the earth's "magnetosphere". The post-SC f_{min} and f_o disturbances are attributed to trapped radiation drifting at relatively low altitudes (below about 2000 km). The southward expansion of the disturbances is a result of the strengthening of the solar stream.

15271 A NOTE ON THE CAUSE OF SUDDEN IONIZATION ANOMALIES IN REGIONS REMOTE FROM HIGH-ALTITUDE NUCLEAR BURSTS. C.M.Crain and P.Tamarkin.

J. geophys. Res. (USA), Vol. 66, No. 1, 35-9 (Jan., 1961).

Sudden changes of VLF propagation characteristics, caused the very high altitude Hardtack nuclear detonations in the summ of 1958, occurred on propagation paths thousands of kilometers from the burst point. The anomalies were caused by bomb-indu ionization in the ionospheric D layer, and their onset was much more sudden than those occasioned by natural phenomena such solar flares. The model discussed provides an explanation of h ionization is suddenly produced in ionospheric regions shadowe from a high-altitude detonation or its conjugate point.

15272 THE D_1, D_2 LAYERS AND THE ABSORPTION OF RADIO WAVES. G.C.Rumi.

J. geophys. Res. (USA), Vol. 65, No. 11, 3625-30 (Nov., 1960).

The dependence of nondeviative radio absorption with freque is analysed for the case of a dichotomic absorbing region that o specific conditions. Selected experimental data are shown to m the theoretical predictions. It is inferred that absorption measu ments may be used to study the splitting of the ionospheric D re into two layers.

15273 IONIZATION OF E-LAYER BY X-RAYS.

S.N.Ghosh and S.Nand.

Indian J. Phys., Vol. 34, No. 11, 516-26 (Nov., 1960).

The transmission curves for solar radiations in the X-ray ultraviolet regions through the earth's atmosphere, obtained fro rocket data and absorption coefficients, are utilized for determi the radiation responsible for E-layer ionization. It is found that only X-rays between the wavelength region 5 to 100 A are absor in the region of the atmosphere occupied by E-layer. The amou of energy absorbed is 0.19 erg cm^{-2} sec^{-1}. The number of ions produced by (1) absorbed X-rays (2) ejected photoelectrons ed by X-rays, and (3) Auger effect induced by X-rays is ated and found to be 4×10^8, 5.6×10^9, and 2.5×10^8 cm^{-2} $column^{-1}$ respectively or the total rate of production of ions E-layer is 6.2×10^9 cm^{-2} sec^{-1} $column^{-1}$. Allowing for the in the measurements of energy from a rocket, this value s with that obtained from substituting the value of effective bination coefficient and electron density for the E-layer in the ssion $q = \alpha Ne^2$. The temperatures of the sun corresponding erent wavelength regions are calculated from data obtained rocket-borne experiments. The calculated values agree with given by Nicolet (1952).

274 SOLAR RADIO EMISSION ON CENTIMETER WAVES AND IONIZATION OF THE E LAYER OF THE IONO- RE.

M.R.Kundu.

ophys. Res. (USA), Vol. 65, No. 12, 3903-7 (Dec., 1960).

t is shown that solar radio emission on any wavelength er than 30 cm is good as a solar index for ionospheric studies. coefficient of correlation between E-layer ionization index and radiation decreases to a low value for wavelengths greater about 30 cm, indicating that a major part of solar X radiation onsible for E-layer ionization originates in the solar atmos- e below the height of origin of 30-cm solar radio emission.

275 THE FORMATION OF THE SPORADIC-E LAYER IN THE TEMPERATE ZONES.

J.D.Whitehead.

nos. terrest. Phys. (GB), Vol. 20, No. 1, 49-58 (Feb., 1961).

A horizontal wind shear leads to vertical movement of ions and rons, which gives rise to the formation of thin layers of ioniza- The probability of the layer appearing depends on the hori- l component of the earth's magnetic field. This is the same as robability observed for sporadic-E critical frequency (f_0E_S) to ed 5 Mc/s in different parts of the world. The hypothesis that mperate zone sporadic-E is due to horizontal wind shears is further support because it shows how sporadic-E once formed end to persist, gives the correct height at which the layer is likely to form and is satisfactory so far as orders of magnitude e various quantities are concerned.

276 GEOMAGNETIC DISTURBANCE EFFECTS IN EQUATORIAL E_S.

B.N.Bhargava and R.V.Subrahmanyan.

nos. terrest. Phys. (GB), Vol. 20, No. 1, 81-4 (Feb., 1961).

5277 NON-SEASONAL VARIATION IN THE E LAYER IONIZATION.

T.Shimazaki.

adio Res. Lab. (Japan), Vol. 7, 95-109 (March, 1960).

Some evidence is presented to show that there is a clear annual -seasonal) component of variations in the electron density of the yer, which gives appreciably larger ionization in December and ary than in June and July. The origin of this non-seasonal ation is sought by considering the effect of geometrical dilution lar radiation owing to the change in the distance between the and the earth, and the effect of solar activity. It is found that e effects cannot explain this non-seasonal component of variations well. A suggestion is tentatively made that it may have some tion to the Van Allen radiation belts.

5278 THE EFFECTIVE RECOMBINATION COEFFICIENT OF AN IONOSPHERE CONTAINING A MIXTURE OF S.

S.A.Bowhill.

mos. terrest. Phys. (GB), Vol. 20, No. 1, 19-31 (Feb., 1961).

The effective recombination coefficient of the normal iono- re may be evaluated from the nocturnal variation of ionization sity; from the rate of change of ionization during a solar eclipse; rom the "sluggishness" of the ionization, as exhibited in its nal variation. These three methods are found to give widely rent results, at any one height in the ionosphere. It is shown an ionosphere containing a mixture of several ion species with rent recombination coefficients, gives adequate explanation of e discrepancies. Formulae are presented for the effective mbination coefficient for this model. A consideration of exist- knowledge of ionization processes in the E-region suggests that ions concerned may be those of molecular oxygen and nitric le, the latter being produced by ion—atom interchange between ogen molecules and atomic oxygen ions. The nocturnal E-region ld then consist primarily of NO^+ ions.

15279 COSMIC NOISE ABSORPTION MEASUREMENTS AT STANFORD, CALIFORNIA, AND PULLMAN, SHINGTON.

B.Lusignan.

eophys. Res. (USA), Vol. 65, No. 12, 3895-902 (Dec., 1960).

Results of cosmic noise absorption measurements at 27.5 Mc/s made at Stanford, California, and Pullman, Washington, during 1958 are presented. A method introduced by Mitra and Shain (1953) of extracting F-layer absorption from total absorption and an extension of this method to remove D-layer absorption are described. Subtracting these two components from the total absorption leaves an extra component of absorption. The diurnal and annual variation of all these components is presented graphically and discussed. Errors in the cosmic noise curves are discovered and corrected for. The cause of these errors and its relation to assumptions of the cosmic noise absorption method is discussed.

15280 OBSERVATIONS OF COSMIC RADIO NOISE AT 18 Mc/s IN HAWAII.

W.R.Steiger and J.W.Warwick.

J. geophys. Res. (USA), Vol. 66, No. 1, 57-66 (Jan., 1961).

Cosmic-radio-noise measurements at 18 Mc/s made in Hawaii during the period of November 1958 to December 1959 are reported. Diurnal attenuation curves are presented for the summer, winter, and equinoctial months that show a very pronounced resemblance to the F-region critical frequency curves. It is shown that an important part of the total attenuation can be accounted for by an ionospheric window effect. The remaining attenuation is attributed to deviative absorption in the F region and nondeviative absorption in the D region. A night-time component of attenuation is observed and it is suggested that this phenomenon is related to the cooling of the ionosphere. Finally, it is observed that on numerous occasions when the F-region critical frequency exceeds the operating frequency, considerable flux continues to arrive at the aerial. It is suggested that this can be accounted for in terms of cosmic radio radiation trapped and propagated underneath the ionosphere. It is also possible that thermal radiation from the ionosphere plays a secondary role in this phenomenon.

15281 WORLD-MAPS OF CRITICAL FREQUENCIES OF THE F_2 LAYER FOR THE SOLSTICE AND EQUINOX MONTHS OF THE YEARS 1954 AND 1957.

P.Herrinck, and J.Goris.

Ann. Geophys. (France), Vol. 16, No. 3, 358-92 (1960). In French.

Hourly world-maps of the F2 critical frequency were prepared for the solstice and equinox months of 1954 and 1957, affording a comparison between periods of minimum and maximum solar activity. They show: (1) The dissymmetrical distribution of ionization over the two hemispheres. (2) The discontinuous movement of the world-maximum ionization during the course of a day: it remains stationary for 11 hours over Formosa, then for 8 hours over Leopoldville-Binza (particularly in March 1957). (3) The existence of four "poles" in the distribution of the mean diurnal rate of increase of the ionization due to solar activity, two of these poles corresponding to the magnetic poles and the other two being located in the equatorial belt where the geomagnetic equator is furthest from the geographic equator.

15282 COMMENT ON MODELS OF THE IONOSPHERE ABOVE $h_{max}F_2$.

J.W.Wright.

J. geophys. Res. (USA), Vol. 65, No. 9, 2595-6 (Sept., 1960).

Evidence for a gradient of scale height in the F region is shown, and discussed in relation to a simple Chapman model of the F region above $h_{max}F_2$. It is suggested that a similar model, but allowing for a scale-height gradient, may give somewhat better agreement with recent observations.

15283 VARIATION OF THE F2-LAYER IONIZATION WITH SOLAR ACTIVITY AT KODIAKANAL ON MAGNETICALLY DISTURBED AND QUIET DAYS.

V.R.Venugopal.

Kodiakanal Obs. Bull. (India), No. 151, 1-5 (Sept. 16, 1959).

A study of the noon F2 layer critical frequencies has been made with a view to find a satisfactory relationship between these and different indices of solar activity, namely, sunspot numbers, areas of sunspots and areas of calcium flocculi. Following Appleton and Piggott (1955) a linear relationship has been tried out. The available data of Kodiakanal extending over a period of about half a sunspot cycle lead to the conclusion that there is a close agreement between the observed and computed values of the critical frequencies. The values of the constants involved have been computed for every month for magnetically quiet and disturbed periods separately and have been compared with similar values for Slough obtained by Appleton and Piggott.

15284 MOVEMENTS IN THE F REGION OF THE IONOSPHERE DURING SOLAR ECLIPSES.

B.N.Bhargava and R.V.Subrahmanyam.
Indian J. Meteorol. Geophys., Vol. 11, No. 4, 363-70 (Oct., 1960).

F layer ionospheric data collected during the partial solar eclipses of 20 June and 14 December 1955 have been analysed. In order to study the effects of the eclipses at several heights, the electron density-height profiles were obtained from the h'-f curves for several levels between 250 and 400 km. Assuming a model of the ionosphere in which electron loss is by an attachment process, the magnitudes of the movement terms of the continuity equation are derived and discussed for the two eclipses and their respective control days.

15285 THE EXOSPHERE AND UPPER F REGION.

F.S.Johnson.
J. geophys. Res. (USA), Vol. 65, No. 9, 2571-5 (Sept., 1960).

The view is presented that the outer portion of the earth's ionosphere, through which radio whistlers propagate, has its origin in the earth's atmosphere rather than in interplanetary space. The outer portion of the earth's neutral-particle exosphere is dominated by neutral atomic hydrogen which is escaping steadily from the earth's atmosphere. Some of this neutral atomic hydrogen reacts with atomic oxygen ions near the base of the exosphere, giving rise to hydrogen ions. Diffusive equilibrium is the dominant factor controlling the relative concentration of ions and neutral particles near the base of the exosphere. At higher levels, the geomagnetic field exerts an influence in that it causes the ions and electrons to rotate with the earth, and the centrifugal force modifies the force of gravitational attraction appreciably. The ion electron plasma through which the radio whistlers propagate is hydrostatically supported within the magnetic tubes of force.

15286 ELECTRON-DENSITY DISTRIBUTION IN THE UPPER IONOSPHERE FROM ROCKET MEASUREMENTS.

J.S.Nisbet.
J. geophys. Res. (USA), Vol. 65, No. 9, 2597-9 (Sept., 1960).

Measurements are given of electron-density distributions above the maximum of the F layer from seven rocket flights. The missiles used for these experiments had large horizontal velocity components, and a matrix method was employed to derive the profiles, account being taken of horizontal gradients, refraction, and the varying ray path zenith angles in the ionosphere. Two methods of measuring ionospheric dispersion were compared: Faraday rotation, and a method using the difference between the apparent positions of the missile obtained by two tracking systems operating on different frequencies. Faraday rotation measurements at two receiving stations and on two frequencies were compared to check the horizontal gradient programme and the polarization of the rocket aerial. The implications of the results are discussed in terms of the structure of the layer and its diurnal variation.

15287 ELECTRON DENSITIES IN THE F REGION OF THE IONOSPHERE FROM ROCKET MEASUREMENTS.

I. METHODS OF ANALYSIS. J.S.Nisbet and S.A.Bowhill.
J. geophys. Res. (USA), Vol. 65, No. 11, 3601-7 (Nov., 1960).

A method is described for analysing dispersion records from long-range missiles in terms of equivalent electron-density and electron-content profiles above a fixed location. This method takes account of varying horizontal gradients in electron density and the varying local zenith angle of the ray path as a function of range time time and height in the ionosphere. Refraction is considered for both Faraday rotation and range-error measurements, and correction factors are included in the programme. Comparisons made between Faraday rotation and range-error measurements and between Faraday rotation measurements at two locations demonstrated the validity of the reduction techniques.

15288 ELECTRON DENSITIES IN THE F REGION OF THE IONOSPHERE FROM ROCKET MEASUREMENTS.

II. RESULTS OF ANALYSIS. J.S.Nisbet and S.A.Bowhill.
J. geophys. Res. (USA), Vol. 65, No. 11, 3609-14 (Nov., 1960).

Electron-density distributions in the ionosphere derived from propagation measurements made during seven long-range missile flights are given. These results are compared with measurements derived from variable-frequency pulse soundings and with satellite and rocket measurements described by others. The vertical electron-density gradient was found to vary within quite a large range, being lowest for two firings that took place shortly after sunset and greatest for the one early-morning firing. The
equilibrium electron-density variation with height was found to t
consistent with the assumption of a Chapman layer, of varying s
height, based on a recent model of the neutral atmosphere deriv
from satellite retardation measurements.

15289 F-REGION TRAVELING DISTURBANCES AND SPORADIC-E IONIZATION.

L.H.Heisler and J.D.Whitehead.
J. geophys. Res. (USA), Vol. 65, No. 9, 2767-73 (Sept., 1960).

Ionosonde records taken at Sydney (33°52' S, 151°11' E) dur
July 1955 were analysed statistically for the occurrence of F-re
travelling ionospheric disturbances and E_s. It is shown beyond
reasonable doubts that the phenomena are associated, and that,
previously suggested by (Abstr. 5536 of 1958), the advent of a
travelling ionospheric disturbance is sometimes accompanied b
increase in E_s critical frequency. An apparent small secondary
effect in E_s occurring some minutes after the F anomaly is also
discussed.

15290 GROUP AND PHASE VELOCITIES OF A TRAVELLI DISTURBANCE IN THE F REGION OF THE

IONOSPHERE. L.H.Heisler and J.D.Whitehead.
Nature (GB), Vol. 191, 157 (July 8, 1961).

It is suggested that travelling ionospheric disturbances pos
a group velocity of order 10 km/min, measured by observations
widely speaced stations, and a phase velocity about half as great
obtained from observations at one station of associated E_s cloud
and other phenomena. (See Abstr. 5536 of 1958, and preceding
abstract). H.Rish

15291 TRAVELLING DISTURBANCES IN THE F-REGION OVER WALTAIR [INDIA].

E.Bhagiratha Rao and B.Ramachandra Rao.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 4, 296-7 (April, 1961

15292 ANALYSIS OF THE VARIATION OF f_0E AND INDEX OF SOLAR ACTIVITY.

H.Shibata and S.Watanabe.
J. Radio Res. Lab. (Japan), Vol. 7, 621-35 (Nov., 1960).

The relationship between f_0E, solar zenith angle χ, and the sunspot relative number R is investigated. From plots of the reports of several stations over a period of twelve years, it is shown that the relation

$$\log f_0e = \log 3.15 + 0.00161R^{0.846} + \frac{1}{4}\log \mathrm{Cos}\,\chi$$

is an appropriate representation. A nomograph of this relation
used to estimate f_0E for values of R. The r.m.s. value of the er
is shown to be approximately 0.14 Mc/s. A brief note on the use
the E layer index as a measure of solar activity is added.

J.J.Mu

15293 SPREAD F AND MULTIPLE SCATTERING IN THE IONOSPHERE.

D.S.Bugnolo.
J. geophys. Res. (USA), Vol. 65, No. 12, 3925-9 (Dec., 1960).

The problem of spread F is examined statistically, and a
resulting theoretical model is obtained to explain the usual spre
F ionogram. The results are applied in detail to a typical exam
of arctic spread F. The statistical model is based on the assum
of Gallet turbulence in the underside of the F layer under night-
time conditions.

15294 THE GEOMORPHOLOGY OF SPREAD F.

D.G.Singleton.
J. geophys. Res. (USA), Vol. 65, No. 11, 3615-24 (Nov., 1960).

An analysis is made of reliable spread-F data obtained fro
IGY f plots for ionosonde stations grouped about longitudes 75°W
and 120°E. The temporal variations of occurrence of the freque
spreading component of spread F are found to change with latitu
these changes having a certain symmetry about the geomagnetic
equator rather than about the geographic or dip equators. Four
regions with different occurrence characteristics appear: two a
regions of high activity, the auroral and equatorial regions; and
other two are regions of lower activity, the middle latitude and pol
regions. The season of minimum occurrence in the equatorial
region changes from the northern summer solstice in the Ameri
zone (75°W) to the southern summer solstice in the Far Eastern
zone (120°E). This longitude effect, which led Reber (1956) to
postulate the existence of a spread-F equator, is shown to be du
the interaction of some form of direct or indirect solar control
the magnetic control of the incidence of the phenomenon.

95 A STUDY OF OBSERVED SPREAD F.

J.Renau.

phys. Res. (USA), Vol. 65, No. 10, 3219-40 (Oct., 1960).

ne main types of spread F are illustrated, and in order to ate their study they are categorized. Thereafter, a study is of the morphology of a particular type of spread F observed ious magnetic and geographic latitudes (northern hemisphere). tal number of ionograms scanned during these studies ts to about a hundred thousand. The first of these studies that the spread F type B (sharp inner and outer frequency may be due either to the bifurcation of the layers or to large ntal patches of ionization with varying degrees of electron y and tilted in a manner to reflect specularly, with scattered s superimposed on the structures thus obtained. As for the t of frequency spreading $f_s = f_{max} - f_{min}$, the spread seems magnetically controlled, having its maximum at the magnetic decreasing with decreasing magnetic latitude down to 40° N, creasing again at the magnetic equator.

296 SOME STUDIES ON THE SPREAD-F, DOUBLE-F AND FORKED-F TRACES AS OBSERVED AT HARINGHATA

CUTTA). R.N.Datta.

J. Phys., Vol. 34, No. 10, 482-92 (Oct., 1960).

rom the spread-F records and from the theoretical relation spread-F index with the critical frequency and the velocity of ularities, it is found that the percentage of occurrence of d-F depends both on the electron density and the velocity of regularities. The night-time appearance of this phenomenon s sharp decrease at sunrise lend support to this conclusion.

297 THE DISTRIBUTION OF MICROMETEORITIES NEAR THE EARTH.

A.R.Hibbs.

ophys. Res. (USA), Vol. 66, No. 2, 371-7 (Feb., 1961).

mpacts of micrometeorites recorded by the artificial satellite rer I in February 1958 were examined statistically to determine their distribution with latitude, altitude, and longitude relative satellite—earth—sun angle (satellite local time). The de distribution shows an interesting peak near the equator, is, however, not statistically significant. The distribution gitude relative to the satellite—earth—sun angle corresponds altitude distribution and apparently contains no information s not better shown in this latter distribution. With suitable sis, the altitude distribution yields information on the velocity particles relative to the centre of the earth. The conclusion t the average particle measured by Explorer I was in a closed around the earth rather than on an impact trajectory from a distance to the surface of the earth.

298 V.L.F. PHASE PERTURBATION ASSOCIATED WITH METEOR SHOWER IONIZATION.

C.J.Chilton.

ophys. Res. (USA), Vol. 66, No. 2, 379-83 (Feb., 1961).

Anomalies associated with the Lyrid, δ-Aquarid, and Perseid or showers were observed on the daily phase variation of the /s transmission from Rugby, England, to Boulder, Colorado. effective reflection heights estimated from these anomalies are 1, and 83 km respectively.

299 ORIGIN OF THE SODIUM AIRGLOW.

A.E.Potter, Jr and B.S.Del Duca.

ophys. Res. (USA), Vol. 65, No. 12, 3915-23 (Dec., 1960).

Comparison of observed and calculated altitude distributions he sodium airglow indicates that airglow processes involving bined sodium cannot account for the observations. It is ested that the airglow results from collisions of neutral ic sodium with vibrationally excited oxygen. This process account for the observed altitude distribution, and, possibly, otal intensity of the sodium airglow.

300 THE DUSK AND NOCTURNAL EMISSION OF THE LINES 6300-6364 A OF O I IN THE UPPER ATMOSPHERE.

bley.

Geophys. (France), Vol. 16, No. 3, 335-57 (1960). In French.

Experimental data about the lines 6300-6364 A of O I during the are presented. An analysis of the twilight effect shows that cale height for O_2 is larger in winter than in summer by a r 2. It is suggested that the vertical transport of the molecular es is responsible for the variation of the scale height.

15301 THE 6300 AND 5577 A RADIATIONS DUE TO OXYGEN IN THE LUMINESCENCE FROM THE NIGHT SKY AT A LOW LATITUDE STATION.

D.Barbier and J.Glaume.

Ann. Geophys. (France), Vol. 16, No. 3, 319-34 (1960). In French.

This paper gives the description of phenomena shown by the lines of oxygen at Tamanrasset Observatory. A very peculiar appearance, an East-West orientated arc, has been discovered. Its altitude and its motions have been studied during a mission accomplished in January 1960.

15302 THE NIGHT-SKY RED LINE AT THE EQUATOR.

A.Delsemme and D.Delsemme.

Ann. Geophys. (France), Vol. 16, No. 4, 507-24 (1960). In French.

The oxygen red line of the airglow was observed at Lwiro (2° S) for 465 hours during 148 nights between December 1957 and April 1959. The observed intensities were corrected for the contributions of the extraterrestrial light, the O H bands and the continuum. Contrarily to its behaviour in high latitudes, the red line often goes through a bright maximum (300 to 900 Rayleighs) around midnight. There exists a seasonal annual variation with a maximum near March and a minimum near September. Correlations with ionospheric data entirely confirm the nocturnal mechanism of the O_2^+ dissociative recombination in the F2 layer. They lead to an O_2 scale height of 38 km at an altitude of about 310 km, which agrees with recent atmospheric models. The surprising behaviour of the red line intensities at the equator can entirely be accounted for by the F2 layer behaviour. The nocturnal secondary maximum of ionization seems to belong to a whole geophysical phenomenon characteristic of the equatorial region.

15303 A STUDY OF THE NIGHT SKY IN THE NEAR INFRARED.

J.Connes and H.P.Gush.

J. Phys. Radium (France), Vol. 21, No. 8-9, 645-54 (Aug.-Sept., 1960). In French.

The spectrum was studied by the Fourier Transform method at a resolution of two thousand in the region 1.6 μ and at a resolution one thousand near 1.0 μ. The rotational structure of the rotation—vibration bands of the OH radical was resolved and the rotational temperature determined. Three different experiments yield the temperatures 227°, 242° and 245°K. It is observed that the intensity of the Q branch is lower with respect to the P branch than is predicted by a theoretical calculation.

15304 DIRECT MEASUREMENT OF PARTICLES PRODUCING VISIBLE AURORAS.

C.E.McIlwain.

J. geophys. Res. (USA), Vol. 65, No. 9, 2727-47 (Sept., 1960).

The nature of the particles producing two visible aurorae at Fort Churchill, Canada, were determined with the aid of rocket-borne detectors. Magnetic fields were used to separate the proton and electron components of the particle flux. It was found in each case that a major fraction of the auroral light was produced by electrons with energies of less than 10 keV. IGY rocket II6.26F was fired into a quiescent auroral glow of about intensity I. The integral number energy spectrum of protons incident upon the atmosphere during this flight was measured to be approximately 2.5×10^6 exp (−E/30) protons sec^{-1} cm^2 ster over the range 80 to 250 keV, where E is the proton energy in keV. The observed altitude dependence of the electron energy flux could have been produced by an integral number energy spectrum equal to 2.5×10^9 exp (−E/5) electrons sec^{-1} cm^2 ster over the range 3 to 30 keV. IGY rocket II6.27F was fired into a bright active auroral arc. At least 75% of the light in this aurora was produced by nearly monoenergetic electrons with about 6 keV energy. The electron flux varied rapidly with time; peak values were about 5×10^{10} electrons sec^{-1} cm^2 ster. The presence of monoenergetic electrons strongly suggests an electrostatic acceleration mechanism.

15305 RADIATION FROM PROTONS OF AURORAL ENERGY IN THE VICINITY OF THE EARTH.

W.B.Murcray and J.H.Pope.

J. geophys. Res. (USA), Vol. 65, No. 11, 3569-74 (Nov., 1960).

Some considerations regarding the way in which auroral protons might be expected to radiate as they approach the earth are discussed. The form of the frequency—time curves which might result at the earth's surface from the radiation by such particles are deduced by assuming a reasonable model of the upper ionosphere. It is concluded, at least so far as the frequency—time curves are concerned, that auroral protons are capable of producing the low-frequency electromagnetic phenomenon known as "Chorus".

15306 A STUDY OF AURORAL CORUSCATIONS.
W.H.Campbell and M.H.Rees.

J. geophys. Res. (USA), Vol. 66, No. 1, 41-55 (Jan., 1961).

Short period variations in the N_2^+ (0,0) auroral emission band represent 5% of the total light in the 3914 A region. These quasi-periodic coruscations have a dominant period of 6 to 10 sec. They attain a maximum amplitude in the predawn hours and are closely related to magnetic field micropulsations and ionosphere absorption of cosmic noise. Spectroscopic triangulation showed that the variations originate in the E region of the ionosphere. The profile of the electron density associated with the aurora was found to have a maximum value of 1.1×10^6 electrons per cm^3 at 98 km.

15307 BALLOON OBSERVATIONS OF X-RAYS IN THE AURORAL ZONE. II.
K.A.Anderson and D.C.Enemark.

J. geophys. Res. (USA), Vol. 65, No. 11, 3521-38 (Nov., 1960).

For Pt I, see Abstr. 14272 of 1960. Data from a long-duration balloon flight at 35-km height over the auroral zone during August 1959 showed that only very small fluxes of energetic X-rays accompany visible auroras at this latitude. The maximum observed photon flux above 25 keV during a bright aurora was 2.5 cm^{-2} sec^{-1}. Much larger fluxes, up to 40 cm^{-2} sec^{-1}, preceded two active visible displays by about half and hour. On August 17 and 18 X-ray influxes were observed for several hours during the daytime. From Explorer VI data these are believed to be associated with the filling-up of the outer radiation belt after a geomagnetic storm. The scintillation counter employed permitted a determination of the X-ray energy spectrum at 6 g cm^{-2} depth from 25 to 300 keV on this and several other flights. From an analysis given here the parent electron spectrum is derived and found to be extremely steep. Typically, the ratio of the differential photon intensity at 30 keV to that at 160 keV is 350 to 1. Other balloon flights during August 1959 show that a large loss of electrons having energy $>$ 25 keV occurs even on magnetically rather quiet days.

15308 CORRELATION OF AN AURORAL ARC AND A SUB-VISIBLE MONOCHROMATIC 6300 A°ARC WITH OUTER-ZONE RADIATION ON NOVEMBER 28, 1959.
B.J O'Brien, J.A.Van Allen, F.E.Roach and C.W.Gartlein.

J. geophys. Res. (USA), Vol. 65, No. 9, 2759-66 (Oct., 1960).

During a severe geomagnetic storm on November 28, 1959, two Geiger tubes on satellite Explorer VII (1959) found anomalies in the outer radiation zone at an altitude of about 1000 km which appear to be correlated in space and time with optical emissions from the atmosphere beneath. Very intense narrow zones of radiation were detected over a visible aurora during one pass. The radiation in three such zones was harder toward low latitudes. On three subsequent passes the radiation zone was deduced to be over a subvisible 6300 A arc, whose brightness diminished as the radiation zones became less intense. The correlation is discussed.

15309 NOTE ON THE DIRECTION OF HIGH AURORAL ARCS.
E.H.Vestine.

J. geophys. Res. (USA), Vol. 65, No. 10, 316-9-78 (Oct., 1960).

The relationships between geomagnetic micropulsations and pulsations in auroral luminosity are considered. Several features are found to be compatible with the concept of drainage of trapped radiation in the region of the outer Van Allen radiation belt in the western hemisphere. Certain homogeneous auroral arcs noted by Stormer at a height of 200 km in central Norway have a mirror point for trapped particles computed to be below ground level in the south Indian Ocean, a region likely to need surveys of the earth's main field. The magnetic-field gradients near the night-time electrojets near the northern and southern auroral zones will change the sign of drift of auroral particles, so that electrons spiraling up or down the geomagnetic-field lines may drift westward in some regions and eastward in others. The gradients of the transient electrojet fields may help to explain many of the complex features of auroral forms, when aurora are formed by incoming charged particles.

15310 THE HEIGHT OF MAXIMUM LUMINOSITY IN AN AURORAL ARC.
F.E.Roach, J.G.Moore, E.C.Bruner, Jr, H.Cronin and S.M.Silverman.

J. geophys. Res. (USA), Vol. 65, No. 11, 3575-80 (Nov., 1960).

The height of maximum luminosity of an auroral arc is estimated from simultaneous observations at three stations in western United States during a night of general auroral activity (November 26-28, 1959). Photometrically this arc is characterized by a selective enhancement of the [O I] 6300 A line. From 24 individual measurements the height is found to be 412 km with a standard deviation of ±23 km for one observation and ±5 km for the mea
The geographical position of the arc, its orientation, and its mo-
ment during the night are discussed.

AURORAL DISPLAY AND HIGH NEUTRON AND RADIATIO INTENSITIES AT BALLOON HEIGHT. See Abstr. 13589

PULSATING AURORA AND IONOSPHERIC ABSORPTION.
See Abstr. 15345

15311 EMISSION SPECTRUM OF THE AURORA AT COLLEGE, ALASKA. L.Herman.

Ann. Geophys. (France), Vol. 16, No. 3, 304-18 (1960).

Extensive semi-quantitative measurements have been made
on spectrograms obtained during the winters of 1957 and 1958 w
an IGY patrol spectrograph at College, Alaska. Preliminary re
concerning the H_α line and the first positive system of N_2 are g
and tentatively interpreted as mainly due to altitude effect.

15312 SPECTROGRAPHIC STUDY OF AURORA POLARIS DURING I.G.Y. AT COLLEGE, ALASKA. L.Herma

Ann. Geophys. (France), Vol. 16, No. 4, 525-43 (1960). In Fren

The relative intensities of the principal radiations of the
auroral spectra obtained during the 1957, 1958 and 1959 winters
College, Alaska are estimated by a quasi-quantitative method.
Preliminary results are given as curves of diurnal variation an
frequency of simultaneous occurence. The ionization and excita
processes of nitrogen molecules by protons with moderate ener
(20 keV) are discussed. The Franck—Condon principle applied
simultaneous processes of ionization and excitation is used to
calculate the population of vibrational levels of the $B\,^2\Sigma$ state of
N_2^+. The results so obtained are in good agreement with the
laboratory data but in disagreement with some observations.
Some pictures of caracteristic or particulary interesting spectr
are given.

15313 AURORAL TEMPERATURE DETERMINATION FRO $A\,^2\Pi \rightarrow X\,^2\Sigma$ BANDS OF THE N_2^+ MOLECULE.
W.G.Mathews and L.Wallace.

J. atmos. terrest. Phys. (GB), Vol. 20, No. 1, 1-8 (Feb., 1961).

A comparison of observed $N_2^+ A\,^2\Pi \rightarrow X\,^2\Sigma(2,0)$ and (3,1) ban
profiles with calculated model intensity profiles at various
temperatures indicates that the auroral rotational temperature
is 350 ± 75°K. This temperature is higher than the average of
the determinations from the $N_2^+ B\,^2\Sigma \rightarrow X\,^2\Sigma$ bands but the differe
is not sufficiently significant to affect the hypothesis that both b
systems have a common excitation mechanism.

15314 ON EMISSION λ 10830 A IN AURORAE.
N.I.Fedorova.

Planet. Space Sci. (GB), Vol. 5, No. 1, 75 (Jan., 1961).

Examples are cited of considerable enhancement of the intensity of the Q-branch of the OH band (λ 10830 A) relative to that of the R-branch in auroral spectra, considered to be due to helium emission. See following abstract. G.M.Br

15315 ON THE NATURE OF HELIUM EMISSION λ 10830 A AURORAE. N.N.Shefov.

Planet. Space Sci. (GB), Vol. 5, No. 1, 75-6 (Jan., 1961).

Increased emission of λ 10830 A observed at the time of
appearance of red aurorae is attributed to the fluorescence of H
atoms in the metastable state 2^3S, originating from electron
bombardment of neutral atoms. Rough calculations give the cor
order of magnitude for the intensity of the emission. See
preceding abstract. G.M.Br

15316 RADIO-ECHO OBSERVATIONS OF THE AURORA IN TERRE ADELIE. K.Bullough.

Ann. Geophys. (France), Vol. 17, No. 2, 195-30 (1961).

Radio-Echo observations of the aurora formed part of the 1
I.G.Y. programme at the French Antarctic base of Dumont D'Ur
(140°01' E, 66°40' S, geomagnetic colatitude 14°20'). The freque
used was 73 Mc/s with an aerial which rotated continuously abo
vertical axis. The station is situated close to the dip pole such
the aspect angle between the radar beam and perpendiculars to
earth's magnetic field lines at a height of 110 km has a minimu
value of about 13° in a south-easterly direction. There was a
marked seasonal variation in the azimuthal distribution of the r
echoes. In winter the activity was concentrated almost entirely
the north of the station whereas in summer there was a marked

of activity to the south with a minimum in the distribution SE. A study of the distribution and displacement of the re- . regions in geomagnetic hour angle/geomagnetic colatitude inates shows that the summer activity can be conveniently into four sectors of geomagnetic hour angle and an inner and one at geomagnetic colatitudes $< 16^\circ$ and $\geq 16^\circ$ respectively. one activity is associated with lower values of the planetary K han outer zone activity and it appears that the activity is ly restricted to a band of geomagnetic latitude from the geo- ic pole outwards, the K_p index being an indication of its ation to moderate latitudes.

17 AUDIO-FREQUENCY ELECTROMAGNETIC RADIATION IN THE AURORAL ZONE.

afsson, A.Egeland and J.Aarons.

hys. Res. (USA), Vol. 65, No. 9, 2749-58 (Sept., 1960).

ring 3 one-month periods, continuous spectrograms of the omagnetic energy in the spectral region between 10 c/s and s were recorded in Kiruna, Sweden. The records were ex- d from the view point of background energy. Throughout the frequency band studied, there is a low daytime signal level night-time maximum. The ratio of the maximum to minimum ude varies as a function of frequency (the higher maximum- imum ratio occurs at the lower frequency range of 20 to s) and with the season of the year. It is concluded that the e ionosphere absorbs the energy throughout the entire spec- studied. It was found that, although strong deviations of the level from the normal were often associated with geomagnetic bances, there was a general lack of correlation between mag- ndex and low-frequency noise, except in the 10 to 45 c/s fre- range. The origin of the background signals is probably two- tmospherics from great distances as well as magnetic and eric fluctuations contributing to the lower band. On eleven ons, electromagnetic radiation associated with micropulsa- of the earth's magnetic field was detected. Two frequency were identified: one centred at 750 c/s, which is the gyro ency for protons at an altitude of 100 km above Kiruna; and the ranging between 1.8 and 4.5 kc/s, which was identified as hiss. but one of the occasions when emissions were detected, the 's signals were quite stable in frequency. During four of the t periods when radiation was recorded, the low-frequency ions were received between two phases of a magnetic storm; pulsations were simultaneously evident on the Kiruna etograms.

18 A NOTE ON THE DISPOSITION OF DAYTIME AURORAL IONIZATION IN SPACE. R.L.Leadabrand.

phys. Res. (USA), Vol. 66, No. 2, 421-8 (Feb., 1961).

he VHF and UHF radar reflection studies of the aurora conducted lege, Alaska, over the past several years resulted in the discovery auroral reflecting region of an entirely different type from any ted previously. It has the following properties: (1) It is a -like region of auroral ionization which uniformly covers at several hundred kilometers in latitude and longitude (at ge). (2) The layer of auroral ionization occurs most frequently the 80- to 130-km height region is sunlit; it is, therefore, arily a daytime phenomenon. (3) The auroral ionization in the is, like other types of auroral ionization, aligned with the etic field. (4) The height of the reflecting layer of field-aligned ation is generally between 80 and 130 km. (5) The occurrence layer of auroral ionization is correlated quite well with etic activity. (6) There is apparently no visual aura that esponds to the occurrence of this layer of auroral ionization. xplanation of the layer-type aurora has been devised that ins all its aspects. However, it occurs at times of high mag- activity, and its field-aligned nature relates it most closely e better-known forms of aurora. The paper includes a ssion of the use of the terms "diffuse" and "discrete" as aining to auroral echoes previously reported in the literature.

5319 THE SLANT E_s ECHO — A HIGH-FREQUENCY AURORAL ECHO. H.F.Bates.

ophys. Res. (USA), Vol. 66, No. 2, 447-54 (Feb., 1961).

Whenever the slant E_s echo was strong on the College oblique- dence, sweep-frequency (1-25 Mc/s) sounder, the College c/s auroral radar recorded an echo at the same range as that 5 Mc/s on the sweep-frequency record. This range was close to at which the line of sight most nearly approaches normal dence upon the geomagnetic field lines. The high-latitude slant echo appears to be the result of energy that is scattered by domly distributed, field-aligned irregularities, and is strongly enhanced by one of two focusing agents that depend upon the frequency. The slanting portion of the echo is produced by least-time focusing, and the constant range VHF portion, by aspect focusing. The high-latitude slant E_s echo is associated with magnetic disturbances; in the cases examined the magnetic K index was between 3 and 7. Its extension at 41 Mc/s is occasionally observed as a discrete type of auroral echo. The scatterers are diffusely distributed, however, indicating that auroral radar records must be interpreted with care.

15320 STRUCTURE OF THE EARTH'S EXOSPHERE.

S.F.Singer.

J. geophys. Res. (USA), Vol. 65, No. 9, 2577-80 (Sept., 1960).

The main components of the earth's exosphere are neutral oxygen, neutral hydrogen atoms, ionized oxygen, and ionized hydrogen. The position of the base of the exosphere is established at an altitude of 530 km, from an analysis of density data obtained from satellite drag observations. The relative distribution of both neutral oxygen and neutral hydrogen is derived from a theory of the exosphere. The normalization of oxygen is accomplished by means of satellite drag data. The normalization of hydrogen is accomplished by means of the Lyman-α technique of Johnson, Friedman and Tousey (1960). The distribution of ionized oxygen can be established jointly from the rocket measurements of Berning (1960) and from an analysis of radiation belt data obtained from satellites. They give a consistent picture of ionized oxygen becoming the most important constituent of the atmosphere at about 1500 km. The distribution of ionized hydrogen is only imperfectly known.

15321 ELECTRON DENSITIES TO 5 EARTH RADII DEDUCED FROM NOSE WHISTLERS. R.L.Smith and R.A.Helliwell.

J. geophys. Res. (USA), Vol. 65, No. 9, 2583 (Sept., 1960).

Whistlers appear to propagate in columns of enhanced ionization aligned with the earth's magnetic field. From nose whistlers a value of 100 electrons cm^{-3} is calculated at 5 earth radii.

15322 RADIO PROPAGATION MEASUREMENTS USING THE EXPLORER VI SATELLITE. C.D.Graves.

J. geophys. Res. (USA), Vol. 65, No. 9, 2585-7 (Sept., 1960).

Presents the results of an experiment to measure the electron density above the ionosphere. The experiment utilized two coherent signals, one VHF and one UHF, transmitted from the Explorer VI satellite. The evidence of the data is that the electron concentration in the vicinity of the satellite, 18 000 km above the earth, was unusually high, of the order of 10^4 electron cm^{-3}. However, the results were influenced by unexpectedly high correction factors and possibly by an intense world-wide magnetic storm that occurred during the measurement period.

15323 A SOUNDING ROCKET MEASUREMENT OF ELECTRON DENSITIES TO 1500 KILOMETERS.

W.W.Berning.

J. geophys. Res. (USA), Vol. 65, No. 9, 2589-94 (Sept., 1960).

At 0700 EST, November 10, 1959, a sounding rocket was launched from Wallops Island, Virginia, for the purpose of measuring electron densities in the high ionosphere. A continuous-wave (CW) technique was employed in the measurement, and the dispersive Doppler effects at 37 and 148 Mc/s were observed. Data are presented indicating derived electron densities to 1500 km for the up-leg of the rocket trajectory. The decrease in electron density above the F_2 maximum indicates a scale height of only 30 km at 270 km but a linear scale-height gradient of 0.45 km/km from 270 to 760 km.

15324 FARADAY ROTATION OBSERVATIONS OF THE ELECTRON CONTENT OF THE EXOSPHERE. R.B.Dyce.

J. geophys. Res. (USA), Vol. 65, No. 9, 2617-18 (Sept., 1960).

The polarization twist imposed on 106.1 Mc/s radio waves by the ionosphere was investigated by using the moon as a passive reflector. This was done with a view to learning the total electron column density even at altitudes above the known ionosphere. Because the antenna is capable of being continuously directed at the moon for 12 consecutive hours, observations are possible from the predawn ionization minimum to the noontime maximum.

15325 AN ESTIMATE OF ELECTRON DENSITIES IN THE EXOSPHERE BY MEANS OF NOSE WHISTLERS.

J.H.Pope.

J. geophys. Res. (USA), Vol. 66, No. 1, 67-75 (Jan., 1961).

The nose whistler dispersion equation was numerically integrated using the following assumed functions for the electron density distribution:

(1) $N = K$.
(2) $N = KR^{-3}$.
(3) $N = KR^{-3} \exp(3.03/R)$.

N is the electron number density, R is the distance from the earth's centre, and K a constant of proportionality. Several whistlers that were received at College on March 19, 1959, were analysed to obtain electron densities. Each of these whistlers consisted of a number of branches having successively lower nose frequencies. Measurements of the nose frequencies and the time of propagation of the nose frequency yield values of the constant K from which the electron density can be determined at any point. It was found that the results for the first two functions disagree systematically with the curve of the assumed function. The third function, suggested by Johnson on the basis of theoretical considerations, fits the data well within the experimental errors. The resulting distributions cover the range between 4 and 6 earth's radii, giving densities varying from 20 to 5 electrons per cm^3.

15326 RADIO WAVE REFLECTIONS FROM THE MESOSPHERE. I. HEIGHTS OF OCCURRENCE. J.B.Gregory.

J. geophys. Res. (USA), Vol. 66, No. 2, 429-45 (Feb., 1961).

An analysis was made of 1 year's hourly observations of 1.75 Mc/s partial reflections from the lower ionosphere at Christchurch, New Zealand (43°S). It is found that partial reflections tend to occur most frequently in regions whose lower boundaries are at 86, 74, 66, 61, and 55 km. The thickness of these regions is estimated to increase with altitude from less than 2 km at 55 km to 5 km or more at 86 km. Several seasonal trends, which are confirmed as of annual occurrence, are found. Chief of these is the 3 to 4 km variation of the mean height of the 86 km region, which is in accord with the height variation of the mesopause. Minor minima in this variation, of about 1 km extent, are found to occur in October-November and in February-March. An annual disappearance of reflections below 65 km is found to occur in late summer and autumn. The diurnal and seasonal variations are shown to be unlikely to arise from the existence of Chapman-type layers. The reflections are considered to be due to turbulent scattering in the presence of a gradient of electron concentration, but the reason for preferential occurrence of turbulence cannot be reconciled with known characteristics of the mesosphere.

15327 MIRROR AND AZIMUTHAL DRIFT FREQUENCIES FOR GEOMAGNETICALLY TRAPPED PARTICLES.

D.A.Hamlin, R.Karplus, R.C.Vik and K.M.Watson.

J. geophys. Res. (USA), Vol. 66, No. 1, 1-4 (Jan., 1961).

For charged particles trapped in the geomagnetic field, the frequencies of the mirror oscillations ω_m and the azimuthal drift ω_d are defined as appropriate averages over the helical motion around the field lines and the mirror motion between reflection points in the two magnetic hemispheres. These integrals for ω_m and ω_d are evaluated numerically. Results are tabulated, illustrated, and represented by approximate analytical expressions.

15328 DEVELOPMENT OF MULTIPLE RADIATION ZONES ON OCTOBER 18, 1959. B.J.O'Brien and G.H.Ludwig.

J. geophys. Res. (USA), Vol. 65, No. 9, 2695-9 (Sept., 1960).

Data from two Geiger counters on Explorer VII indicate that anomalous radiation zones developed around 1000 km altitude on the low-latitude side of the outer radiation zone during a moderate magnetic storm on October 18, 1959. The zones were first detected as quite separate regions of increased counting rates, each region about 0.5° thick in latitude. Later, other narrow zones were seen to be superimposed on a 6°-thick zone of steadily increasing intensity. At one time, this broad zone contained radiation even more intense than that in the normal outer zone. The anomalous radiation disappeared within a few days as the outer zone returned to its prestorm condition. Correlation with ionospheric data indicates that much of the detected radiation was trapped for some hours at least. A qualitative explanation of the phenomena is suggested.

15329 ELECTRONS OF THE VAN ALLEN RADIATION. P.J.Kellogg.

J. geophys. Res. (USA), Vol. 65, No. 9, 2705-13 (Sept., 1960).

Calculations are presented for the flux of trapped electrons to be expected on the hypothesis that these electrons are β-decay electrons from neutrons produced in the atmosphere by cosmic rays. It is shown that such electrons can form only a very small part of the observed electron component even in the inner zone. Furthermore, the observed energy spectrum is shown to be different from that expected from neutron β-decay, and so other sources of neutro not worth considering. It is concluded that the observed electr are most probably accelerated in place by high-frequency elect-magnetic fields.

15330 X-RAYS FROM VAN ALLEN BELT ELECTRONS. J.B.Cladis and A.J.Dessler.

J. geophys. Res. (USA), Vol. 66, No. 2, 343-50 (Feb., 1961).

The X-ray spectrum due to atmospheric absorption of Van Allen radiation belt electrons is calculated, on the assumption small-angle atmospheric scattering is the dominant loss mecha for these electrons. It is concluded that the X-ray flux, althoug highly variable, at peak intensity should be detectable above the cosmic radiation background at balloon altitudes. A detailed s of balloon measurements of the X-ray flux at several locations around the earth, including the Capetown region, could provide quantitative data on the rate at which electrons are lost from th radiation belt and, therefore, information on the Van Allen elect source strength. Such measurements would provide an experimental test to differentiate between the neutron decay origin an the local acceleration origin for the Van Allen belt electrons. Furthermore, it should be possible from such observations to m a definitive statement whether the primary loss of outer-zone electrons occur through atmospheric scattering or through rapi "dumping" during geomagnetic storms. Specific balloon experiments are suggested.

15331 RADAR METHODS OF MEASURING THE CISLUNA ELECTRON DENSITY.

V.R.Eshleman, P.B.Gallagher and R.C.Barthle.

J. geophys. Res. (USA), Vol. 65, No. 10, 3079-86 (Oct., 1960).

The ionized medium between the earth and the moon is bein studied at Stanford by means of lunar radar echoes. Of prime interest is the electron density beyond the earth's ionosphere, i regions (at distances of several to 60 earth radii) where the inte planetary gas may be dominant. Six related techniques for mea the total integrated electron density are discussed. In practice ionospheric part could be determined separately and subtracted the total. These same techniques could be used to measure by radar the electron density between the earth and various planets, a measure by one-way propagation the integrated electron density between a space probe and the earth. The moon's radar range exceeds the true range, especially at low frequencies, because group retardation, which is a measure of integrated electron de Density measurements based on absolute measures of radar ra would require very high peak power (for pulse ranging) or very high equipment stability (for CW ranging); furthermore, the true lunar range is not known accurately. In two of the methods described here, the full average-power capability of the transmit can be used without need for high stability or precise knowledge of the lunar range. In effect, a reference is sent with the measu quantities and only relative radar range is measured. Doppler frequency shifts and the earth's magnetic field cause only slight difficulties. However, path splitting, electron "blobs," and luna surface irregularities possibly could affect the waves more tha electrons do. The measurements might then yield information about the lunar surface or about the temporal and spatial variat of the cislunar medium.

15332 THE RADIATION BELT PRODUCED BY NEUTRONS LEAKING OUT OF THE ATMOSPHERE OF THE EA

W.N.Hess.

J. geophys. Res. (USA), Vol. 65, No. 10, 3107-15 (Oct., 1960).

Calculations of the radiation belt spectra and fluxes based o the neutron decay source are compared with the experiments. T purpose is to find out in what ways the neutron decay source explains the observed features of the radiation belt and where o sources may be needed. The conclusion reached is that the inne zone of the radiation belt is quite likely supplied by neutron dec alone and also the e$_2$ region of the outer zone may well be due t neutrons alone but that there may be another source of particles that supplies electrons of less than 100 keV to the e$_3$ region of t outer zone.

15333 DISCUSSION OF PAPER BY R.L.ARNOLDY, R.A.HOFFMAN, AND J.R.WINCKLER, "OBSERVAT OF THE VAN ALLEN RADIATION REGIONS DURING AUGUST AND SEPTEMBER 1959. I." A.J.Dessler.

J. geophys. Res. (USA), Vol. 65, No. 10, 3487-90 (Oct., 1960).

The bremsstrahlung measurements of electron flux in the radiation zone (Abstr. 14267 of 1960) are criticized on grounds inconsistency with other radiation measurements and geomagne

ata. It is suggested that the flux of electrons (> 30 keV)
t exceed 10^{14} m^{-2} sec^{-1}, less than one-tenth of the result of
emsstrahlung experiments. H.Rishbeth

34 CHARGED-PARTICLE VARIATIONS IN THE OUTER VAN ALLEN ZONE DURING A GEOMAGNETIC STORM.
arley and A.Rosen.
phys. Res. (USA), Vol. 65, No. 10, 3494-6 (Oct., 1960).
esults of the Explorer VI scintillation-counter experiment
scribed. During a magnetic storm in August 1959, the flux
rged particles was enhanced after the sudden commencement
contrast to the decrease observed by bremsstrahlung
ors (Abstr. 14267 of 1960) — and within two days had increased
nty times the pre-storm flux. There were rapid fluctuations
ticle intensity, correlated with the variations of magnetic
t the satellite (Abstr. 12133 of 1960). H.Rishbeth

335 CHARGED PARTICLES IN THE INNER VAN ALLEN RADIATION BELT.
rmstrong, F.B.Harrison, H.H.Heckman and L.Rosen.
phys. Res. (USA), Vol. 66, No. 2, 351-5 (Feb., 1961).
nuclear emulsion stack was flown through the lower part of
ner Van Allen radiation belt a few days after the intense solar
of July 10-16, 1959. The stack "looked-out" through a thin
w on the mounting plate at the rear of the nose cone. Protons
ncident energies down to 42 MeV were recorded. The total
s about $\frac{1}{3}$ that reported by Freden and White (Abstr. 12903 of
; the difference may be due to the lower peak altitude of the
reported here. Above 100 MeV the proton spectrum is
stent with the neutron albedo hypothesis. Below 100 MeV,
ver, there is evidence of structure, with a peak or plateau in
egion of 80 MeV. This structure may be due to solar protons.

336 HYDROMAGNETIC WAVES AND THE TRAPPED RADIATION. I. BREAKDOWN OF THE ADIABATIC
RIANCE. D.G.Wentzel.
ophys. Res. (USA), Vol. 66, No. 2, 359-62 (Feb., 1961).
The magnetic moment of a charged particle travelling through a
magnetic wave does not remain constant. The motion through
l, static, transverse perturbations of a uniform magnetic field
lculated. The changes of the magnetic moment are not random.
depend strongly on the number of wavelengths traversed by
article during one Larmor period and on the pitch angle of
yration. For sinusoidal waves a resonant decrease of the
ent may occur when the particle traverses 0.5 wavelength per
nor period. For sufficiently peaked waves the moment generally
eases if the particle traverses less than about 0.3 wavelength
armor period.

337 HYDROMAGNETIC WAVES AND THE TRAPPED RADIATION. II. DISPLACEMENTS OF THE MIRROR
TS. D.G.Wentzel.
ophys. Res. (USA), Vol. 66, No. 2, 363-70 (Feb., 1961).
Theoretical estimates on the nature of hydromagnetic waves
e magnetosphere are reviewed. The calculations mentioned
previous abstract are applicable near the inner Van Allen belt.
magnetic moment of a fast proton may change significantly
e day. After the mirror point of a proton injected within the
is raised or lowered by at most a few hundred kilometres the
etic moment remains constant. A stationary velocity-depend-
istribution of mirror points is established. The existence
inite spatial extent of the inner Van Allen belt are associated
the peak in the hydromagnetic-wave velocity in that region.
lts indicate that mirror points of protons above the belt are
inuously lowered into the atmosphere. The disappearance of the
s electrons during a geomagnetic storm is discussed.

338 A STUDY OF VARIATIONS OF THE CORPUSCULAR RADIATION OBSERVED BY SATELLITE 1958 EPSILON.
R JAPAN. M.Hirono and H.Akima.
Ionosphere Space Res. Japan, Vol. 14, No. 1, 41-68
rch, 1960).
The telemetering signals from Satellite 1958 Epsilon were
ived at Kokubunji and the data analysed. It appears that the
s I electron shell was detected. Increases of corpuscular
ation were observed between the altitudes 500 and 1000 km
the region around the geographic latitude 45° N and longitude
E. The downward leakage of the electrons due to scattering
he air near the minimum mirror altitude is shown to play an
ortant role in the observed increases. Finally the relation
een the radiation and the ionosphere is discussed. It is point-
ut that the heating effect of the radiation in the Van Allen belt
upon the ionosphere is negligibly small except near the auroral zone. The temperal increase of the ionization in the lower ionosphere may at times be due to the increased corpuscular radiation.

GEOMAGNETISM

15339 NOTE ON THE GEOMETRY OF THE EARTH MAGNETIC FIELD USEFUL TO FARADAY EFFECT EXPERIMENTS. K.C.Yeh and V.H.Gonzalez.

J. geophys. Res. (USA), Vol. 65, No. 10, 3209-14 (Oct., 1960).

The geometric factor (M) involving the earth's magnetic field in the Faraday effect equation is studied. A total of 48 coefficients is used to compute this factor. Some representative curves are shown. It is found that in general this factor is not a constant for a given ray. However, when a ray passes near the saddle point of the "M-surface", M can be assumed to be constant along the ray with reasonable accuracy. In other regions of the sky an empirical average value of M must be used for a given ray and its value depends on the direction of the ray and the a priori ionization density profile. The results are compared with values computed by using the earth's dipole field.

15340 EQUATION OF A CHARGED PARTICLE SHELL IN A PERTURBED DIPOLE FIELD. R.H.Pennington.

J. geophys. Res. (USA), Vol. 66, No. 3, 709-12 (March, 1961).

The earth's magnetic field is considered to be described as a dipole perturbed by the addition of higher-order poles of small magnitude and an equation is given for the shell generated by the motion of a trapped, charged particle. The equation is shown to be in agreement with the shell measured by satellite 1958 ϵ following the high altitude nuclear detonation of September 6, 1958. Magnetic field coefficients in various coordinate systems are given.

15341 LOW-LATITUDE AND HIGH-LATITUDE GEOMAGNETIC AGITATION. E.R.Hope.

J. geophys. Res. (USA), Vol. 66, No. 3, 747-76 (March, 1961).

At high latitudes there are statistical morning, afternoon, and night maxima of geomagnetic agitation (irregular disturbance or activity), the complicated distribution and seasonal behaviour of which can be explained only in terms of patterned corpuscular bombardment. At subequatorial latitudes there are noon, afternoon, and night maxima, of which only the last two are related to the corresponding high-latitude maxima; the noon maxima, which differs in character from the others, represents a locally generated (Sq) agitation, presumably due to direct solar radiation. Since the afternoon and night maxima are traceable continuously from auroral through middle to low latitudes, and since their respective seasonal variations are everywhere the same, they may be explained as agitation transported from high to low latitudes by an ionospheric current system resembling (and probably identical with) the SD circulation. If so, this circulation is a physical reality, not an analytical construction; the SD currents must flow at their own level, independently of the Dst and Sq circulations. Besides the SD and Sq components of current-transported agitation, there is also a Dst component which, so far as identified, represents pulsative compressions of the geomagnetic field. Sudden commencements have SD, Sq, and Dst components largely analogous to those of agitation.

15342 THE DIURNAL VARIATION OF K INDICES OF GEOMAGNETIC ACTIVITY ON QUIET DAYS IN 1940-1948. S.B.Nicholson and O.R.Wulf.

J. geophys. Res. (USA), Vol. 66, No. 4, 1139-44 (April, 1961).

Local- and universal-time components of the diurnal variation of the K indices have been computed from the eight daily K numbers for the 10 quiet days of each month in the 9 years 1940-1948 from six observatories in moderately low latitudes and fairly evenly distributed in longitude. Because the quiet days were universal time days, the universal time component contains a statistical curvature effect. The magnitude of this was estimated. The universal time component is less regular than the local time component. When the local time component is examined for each of the 9 years separately, a pronounced change in form of much apparent regularity is exhibited over this 9-year interval. While it is possible that the variability of the amplitude and form of the quiet-day daily variation of the field contributed appreciably to the K numbers for these quiet days, it seems probable that this change of form of the local-time component, particularly marked from 1943 to 1947, arises mainly from disturbance and represents a change in the relative amounts of disturbance having different forms of diurnal variation. It may represent a change of this distribution with the solar cycle.

15343 ON THE SEASONAL VARIATION IN LUNAR AND SOLAR GEOMAGNETIC TIDES IN THE GEOMAGNETIC EQUATORIAL REGION.

K.S. Raja Rao.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 4, 289-94 (April, 1961).

Following the method outlined by Chapman and Miller (1940), the lunar L(H) and solar S(H) geomagnetic tides at Kodaikanal (geomagnetic latitude $+0.6^{\circ}$) are determined for the three seasons — December solstice, June solstice and equinox, making use of the hourly values of horizontal intensity for the years 1950-1955. The seasonal variation of the amplitude of L(H) at Kodaikanal is compared with similar results for Huancayo (geomagnetic latitude -0.6°) and Ibadan (geomagnetic latitude $+10^{\circ}$). It is seen that the amplitude of L(H) at Kodaikanal is larger in December solstice than in June solistice, similar to the variation at Huancayo and Ibadan. It is, therefore, concluded that the ionospheric currents causing geomagnetic tides are not symmetrical with respect to the geomagnetic equator; but the southern hemisphere currents extend into the northern hemisphere up to 10°N geomagnetic latitude in December solstice. It is likely that the region of separation of the northern and southern hemispheric currents is not static, but oscillates northwards and southwards across the geomagnetic equator. The type of seasonal variation in the amplitudes and phases of the lunisolar variations is markedly different from the variations in the higher latitudes. There is no significant seasonal variation in the amplitude of S(H) in the geomagnetic equatorial region.

15344 GEOMAGNETIC SECULAR VARIATION DURING THE PERIOD FROM 1955 TO 1960.

T.Nagata and Y.Syono.
J. Geomagn. Geoelect. (Japan), Vol. 12, No. 2, 84-98 (1961).

Isoporic charts of $\dot{X}$, $\dot{Y}$ and $\dot{Z}$ of geomagnetic secular variation during the period from 1955 to 1960 were constructed using data from 99 stations over the earth's surface including the Antarctic region. From the results of spherical harmonic analyses of these isoporic charts, it is concluded that (a) the earth's magnetic dipole is decreasing in moment at the rate of -4.4×10^{22} emu/yr, the magnitude at 1960.0 being 8.046×10^{25} emu; (b) the eccentric dipole is drifting westwards by 18′/yr, northwards by 12′/yr, and outwards by $3.4 \times 10^{-4} \times$ the earth's radius/yr. It is shown that the other harmonics are drifting mostly westwards at the rate of several tenths of a degree per year. On the other hand, very intense foci of isopors are found in the Antarctic region, amounting to about 200 γ/yr in $\dot{Z}$. The current change on the surface of the earth's core equivalent to the foci amounts to about 0.1 A cm^{-1} yr^{-1}. This value is strikingly large compared with intensity of the equivalent current of the earth's magnetic dipole, which is about 0.5 A/cm in this region.

15345 MAGNETIC MICROPULSATIONS, PULSATING AURORA, AND IONOSPHERIC ABSORPTION.

W.H.Campbell.
J. geophys. Res. (USA), Vol. 65, No. 6, 1833-4 (June, 1960).

A relationship between geomagnetic micropulsations and pulsating aurorae previously reported (see Abstr. 1585 of 1961) was extended to include concomitant increases in 27.6 Mc/s ionospheric absorption. Records of each variable are reproduced for the event of 8th March 1960. D.R.Barber

15346 PULSATION OF THE EARTH'S ELECTROMAGNETIC FIELD WITH PERIODS OF 1 TO 15 SECONDS AND THEIR CONNECTION WITH PHENOMENA IN THE HIGH ATMOSPHERE.

V.A.Troitskaya.
J. geophys. Res. (USA), Vol. 66, No. 1, 5-18 (Jan., 1961).

The first results of investigations of earth current pulsations in the range of periods of 1 to 15 seconds are presented. Data of earth current stations located in the Arctic (5 stations), in the Antarctic (2 stations), and in middle latitudes of the USSR (10 stations), as well as data of high-sensitivity installations for magnetic-field (Z) registration at 3 stations, were used. Several characteristic types of pulsations were defined in this range of periods, and their correlation with phenomena in the high atmosphere was studied, among them: (a) short irregular pulsations ($T \sim 1$-15 sec) composing the microstructure of several forms of macroscopic disturbances of the magnetic field and showing a close correlation with aurora; and (b) pulsations of the 'pearl' type ($T \sim 1$-4 sec), distinguished by their regular form and showing a correlation with cosmic-ray intensity bursts in the stratosphere. The main features of magnetic-storm microstructure, as well as the microstructure of SSC, are given. The importance of the occurrence during magnetic storms of 'pulsations with diminishing periods' and correlati studies with high-atmosphere phenomena is stressed. The deper ence on local time of the fine structure of SSC is described. Co trary to some theoretical expectations the time difference betwe the first movements due to SSC was found to be very small; the movements may even have been simultaneous. For the Argus II explosion the onset time of oscillation was found to be within 1 s

15347 THE CAUSE OF MAGNETIC STORMS AND BAYS.

R.A.Duncan.
J. geophys. Res. (USA), Vol. 65, No. 11, 3589-92 (Nov., 1960).

Because of the Hall effect, electric current will circulate a clockwise around an area of proton precipitation and clockwise around an area of electron precipitation (in the northern hemisp This is suggested as the cause of the current systems of magne bays and storms. The observed geophysical distribution of aur hydrogen emission, polar blackout, and auroral E ionization is to suggest that the required pattern of protons and electron pre tation occurs.

15348 GEOMAGNETIC STORM SUDDEN-COMMENCEMEN RISE TIMES.

A.J.Dessler, W.E.Francis and E.N.Parker.
J. geophys. Res. (USA), Vol. 65, No. 9, 2715-19 (Sept., 1960).

Adopting the view that the sudden commencement of a geomagnetic storm (SC) is the result of the impact on the geomagne field of an abrupt solar-plasma front, the form of the SC observ on the surface of the earth is investigated. A model is construc to represent the shape of the geomagnetic field boundary as perturbed by the solar plasma. Calculations (carried out in the eq torial plane for simplicity) show that, regardless of how abrupt be the impact of a solar-plasma front on the geomagnetic field, variation in hydromagnetic transit times from different position the boundary, down to a point on the surface of the earth, yields rise times of several minutes at ground level. These times are agreement with the observed SC rise times.

15349 LARGE-SCALE ELECTRON BOMBARDMENT OF T ATMOSPHERE AT THE SUDDEN COMMENCEMEN OF A GEOMAGNETIC STORM.

R.R.Brown, T.R.Hartz, B.Landmark, H.Leinbach and J.Ortner.
J. geophys. Res. (USA), Vol. 66, No. 4, 1035-41 (April, 1961).

A burst of X-rays was observed at balloon altitude over Al with the onset of a sudden commencement geomagnetic storm a 0146 UT on June 27, 1960. The electron bombardment of the up atmosphere that gave rise to the X-rays occurred on a large sc ionospheric absorption coincident with the X-ray burst being observed by riometers in Alaska, Sweden, and Norway.

15350 THE SIMULTANEITY OF GEOMAGNETIC SUDDEN IMPULSES.

M.Yamamoto and H.Maeda.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 212-15 (March,

15351 ON THE EARTH STORMS. I. GENERAL INTRODUCTION.

T.Nagata
Rep. Ionosphere Space Res. Japan, Vol. 14, No. 3, 247-9 (Sept., 1960).

15352 ON THE EARTH STORMS. II. STABILITY OF SOL CORPUSCULAR STREAM.

A.Nishida.
Rep. Ionosphere Space Res. Japan, Vol. 14, No. 3, 250-8 (Sept., 1960).

In order to see whether or not the non-magnetized stream coming from the sun can be the cause of earth storms, an atte was made to examine the stability of it during its propagation in interplanetary space. Although electrons in the stream are expelled away from the streams due to collision with the interplanetary plasma and the stream comes to be composed only of protons, the space charge thus introduced is sufficiently neutral by the change in density of interplanetary plasma, and the non-magnetized stream can propagate stably both when there is no magnetic field, and when there is a radial field in interplanetar space.

15353 ON THE EARTH STORMS. III. INTERACTION BETWEEN THE SOLAR CORPUSCULAR STREAM THE EARTH'S MAGNETIC FIELD.

N.Matuura and T.Nagata.
Rep. Ionosphere Space Res. Japan, Vol. 14, No. 3, 259-72 (Sept. 1960).

The effect of a stream of solar particles upon the exosphe examined. Heating of the exospheric gas owing to compression the magnetic field corresponding to sudden commencement may produce such intense world wide hydromagnetic instability in th

here as is required. Alternatively, random penetration of
particles under the influence of an irregular magnetic field is
with. Solar particles of energy 20 keV may penetrate into the
here near five times the earth's radius from the centre of the
, about 10^5 seconds after the arrival of the solar stream.
, maximum density of the penetrated particles is ~ 10^3 cm^{-3},
the stream density is assumed to be 10^3 cm^{-3}. The effect of
penetrated particles as the cause of magnetic disturbance is
ssed.

5354 ON THE EARTH STORMS. IV. POLAR MAGNETIC STORMS, WITH SPECIAL REFERENCE TO RELATION
VEEN GEOMAGNETIC DISTURBANCES IN THE NORTHERN SOUTHERN AURORAL ZONES.

T.Nagata and S.Kokubun.

Ionosphere Space Rep. Japan, Vol. 14, No. 3, 273-90 (Sept.,
.

Characteristics of the south polar magnetic disturbances are
ared with the north polar ones. (1) The SD-field pattern in the
polar region is almost a mirror image of that in the north
region with respect to the geomagnetic equatorial plane.
-indices at Syowa station (–69.°7, 77.°6 in the geomagnetic
dinates) are almost always parallel to Kp, which may be
esentitive of the northern high latitude geomagnetic activities,
ifference between K figures at Syowa and Kp figures being less
2 in 98% of the total cases. Local disturbances over Syowa of
occurrence frequency are proved to be local by observation of
head auroral displays and overhead ionospheric black-outs.
ne-to-one correspondence of individual geomagnetic disturb-
s between geomagnetically conjugate points in the north and
polar regions is especially good for case of isolated bay-
variations at local night time. Correlation coefficient in such
e between 10 min average values of disturbances at Baker Lake
7, 315.°1 geomag.) and Little America (–74.°0, 312.°0 geomag.)
nts to 0.85. This correlation is much better than that between
r Lake and another northern station further away than the
nce between Little America and the geomagnetically conjugate
of Baker Lake. This result may indicate that the corpuscular
m originating in outer space tends to flow in along geo-
etic lines of force towards both their north and south ends on
arth's surface. In case of large magnetic storms, the
elation between geomagnetically conjugate points on quiet
is much poorer, suggesting that the relation between the two
s linked by a geomagnetic line of force is much disturbed
to heterogeneous magnetic field in outer space.

5355 ON THE EARTH STORMS. V. INTER-RELATIONS AMONG THE UPPER ATMOSPHERE DISTURBANCE
NOMENA OVER THE POLAR REGIONS.

T.Oguti.

Ionosphere Space Res. Japan, Vol. 14, No. 3, 291-300 (Sept.,
).

Inter-relations among the upper atmosphere disturbance
omena in the auroral zone are discussed using observations at
a Station (69°00'S, 39°35'E). Results obtained can be
marized as follows: (1) Geomagnetic bay type disturbances,
spheric disturbances represented by anomalous increase in
and blackout and abrupt increase of auroral luminosity λ 5577
enith begin simultaneously with each other within the accuracy
servation. It is noteworthy that the onset of increase of
ral zenith luminosity, not of total activity, is simulaneous with
e of the other disturbance phenomena. (2) Ionospheric blackout
ws geomagnetic disturbances and auroral displays at the
ning day-time site of the auroral zone, while increase in fEs
ws those at the evening night-time site. (3) Numerical values
esenting activity of disturbances, e.g. decrease of geomagnetic
zontal intensity, increase in fEs and auroral λ 5577 zenith
sity, are found to be consistent with each other if it is postul-
that these disturbance phenomena are due to anomalous
zation in the lower ionosphere with simulaneous excitation
ng auroral displays. (4) From the observed facts mentioned
e, these disturbance phenomena may be tentatively interpreted
ostulating that they are all derived from impinging particles
the upper atmosphere in the auroral zone.

15356 ON EARTH STORMS. VI. ENERGY AND FLUX OF CORPUSCULAR STREAMS IMPINGING THE EARTH'S ATMOSPHERE.

T.Tohmatsu and T.Nagata.

Rep. Ionosphere Space Res. Japan, Vol. 14, No. 3, 301-19 (Sept., 1960).

The energy and flux of the corpuscular streams impinging on the earth's upper atmosphere during earth storms are estimated from their ionizing and exciting effects in the polar regions. The studies were made for three zones in the polar regions, which are characterized by energy and flux of the invading particles. (1) The ionospheric disturbance in the polar cap ($\varphi>60^0$) will be due to the bombardment of proton flux of $10-10^3$ cm^{-2} sec^{-1} with energy 1–100 MeV. No optical enhancement is expected in this case. (2) In the auroral zone, it is considered that both protons and electrons take part in ionizations and optical excitations according to the stage of the storm. The proton flux for energy higher than 100 keV, when it is estimated from the intensity of hydrogen emissions, is about 2×10^7 cm^{-2} sec^{-1} in the homogeneous arc. In the main phase of auroral display, electrons with energy, 1 – 100 keV may take an important role in optical phenomena, sporadic ionization and unusual increase of radio-wave absorption. The electron flux is estimated to be $10^7 - 10^9$ cm^{-2} sec^{-1}. (3) The red aurora in the lower latitudes which is characterized with the preferential enhancement of [OI] λ 6300 radiation, is likely to be excited by either electrons with energy, 100 – 1000 eV, or protons with energy, 1 – 10 keV. The dissociative recombination of electrons with O_2^+ would be responsible for this isolated enhancement of the λ 6300 radiation.

CHARGED-PARTICLE VARIATIONS IN THE OUTER VAN ALLEN ZONE DURING A GEOMAGNETIC STORM. See Abstr. 15334

15357 GEOMAGNETIC FLUCTUATIONS AND THE FORM OF THE OUTER ZONE OF THE VAN ALLEN RADIATION BELT.

E.N.Parker.

J. geophys. Res. (USA), Vol. 65, No. 10, 3117-30 (Oct., 1960).

It is demonstrated by formal calculation that the large-scale geomagnetic fluctuations observed at ground stations result in a rapid and somewhat remarkable kind of diffusion of the electrons in the outer zone of the Van Allen radiation belt. An initial thin ring of electrons will give an immediate finite particle flux at infinity, at the same time that the group of the particles remaining moves radially inward as a "wave." A decline of particle counting rate beyond about 4 earth radii of the order of $1/r^{\beta}$, where $\beta \cong 12$ to 16 is predicted, depending upon the kind of counter, in agreement with the many observations.

GEOMAGNETIC, AURORAL, IONOSPHERE AND COSMIC RAY DISTURBANCES: INTERDEPENDENCE AND RELATION WITH SOLAR ACTIVITY. See Abstr. 15250

15358 THE INTERACTION OF THE TERRESTRIAL MAGNETIC FIELD WITH THE SOLAR CORPUSCULAR RADIATION.

D.B.Beard.

J. geophys. Res. (USA), Vol. 65, No. 11, 3559-68 (Nov., 1960).

The terrestrial magnetic dipole field is assumed to exist in an intense stream of protons and electrons emanating from the sun which behaves as a diamagnetic medium terminating the earth's magnetic field at about 7 earth radii on the daylit side and up to perhaps 100 earth radii on the night side of the earth. By detailed examination of particle trajectories the interaction between plasma and magnetic field is shown to occur within a negligibly thin current sheath enveloping the earth. Numerical solutions of the differential equation for the sheath surface reveals an approximately spherical surface on the daylit side giving rise to a more complicated expanding surface on the night side, including a prominent bump of reversed current sheath near the magnetic poles.

15359 INFLUENCE OF SUNSPOTS ON GEOMAGNETIC DISTURBANCE.

F.Ward and R.Shapiro.

J. geophys. Res. (USA), Vol. 66, No. 3, 739-46 (March, 1961).

The hypothesis that the ejection of solar corpuscles is influenced by interactions of "active region" magnetic fields is tested empirically. The results do not support the hypothesis.

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

15360 PHYSICAL PROTECTION AGAINST X-RAYS.

H.Izadian.

Ann. Phys. (France), Vol. 5, No. 11-12, 1615-28 (Nov.-Dec., 1960). In French.

The deleterious effect of X-rays on biological media lies in the oxidation of their water content to H_2O_2. Tubes of distilled water were subjected to X-radiation and chemically tested for the peroxide. The amount of this increased linearly for one hour of radiation, then continued to rise at a reduced rate. When the water was subjected simultaneously to X-radiation and illumination by a source of white light the rate of peroxide formation fell by a third. The material and size of the tubes made little difference.

A.E.I. Research Laboratory

15361 THE USE OF THE BIOLOGICAL DOSAGE QUANTITY "REM" IN PROTECTION AGAINST RADIATION.

U.Hagen and H.Langendorff.

Atomkernenergie (Germany), Vol. 5, No. 5, 173-81 (May, 1960). In German.

The dosage value "rem" depends on two quantities: the dosage of a given type of radiation, which can be measured physically in "rad", and the relative biological effect (RBE) of this radiation as compared with radium rays, γ-rays or X-rays. In order to have a safe basis for legislation on protection against radiation, the RBE of radiation must be defined clearly in addition to the physical dose. Such a schematic description of the RBE in the regulations is only possible with reservations. Based on extensive experimental studies on the RBE in mammals, it is shown that the RBE of the various symptoms of radiation disease increases with increasing specific ionization of radiation but decreases in radiation with very high specific ionization. A number of other factors also influence the RBE of a specific radiation symptom. In cases of acute irradiation, RBE values above 5 have not been measured recently. The RBE of various radiations is possibly much greater in chronic irradiation; however, the statistics at hand are as yet insufficient for any interpretation.

15362 SPECTRAL FLUX DENSITY OF SCATTERED AND PRIMARY RADIATION GENERATED AT 250 kV.

L.D.Skarsgard and H.E.Johns.

Radiation Research (USA), Vol. 14, No. 3, 231-60 (March, 1961).

The spectral distribution of radiation at points within water phantoms were measured using a scintillation spectrometer, which is described, and a computer to perform the corrections for counter response distortions and to process the derived data. Detailed tables of spectral distribution (photons per square centimetre per 10 keV for 100r in air) are given for radiation qualities of 1.25, 2.20 and 3.20 mm Cu H.V.L. from a 250 kV constant potential X-ray unit. Results for both primary radiation and scattered radiation are given for depths of 0, 2.5, 5.0, 10.0 and 15.0 cm with field areas 25, 50, 100, 200 and 400 cm^2 respectively. This information is required for calculation of linear energy transfer distributions for various points in a water-equivalent homogeneous medium.

J.R.Mallard

15363 A TOTAL BODY IRRADIATION CHAMBER AND ITS USES. M.L.Jacobs and L.Pape.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 141-3 (July, 1960).

The chamber at the City of Hope Medical Centre, California, is approximately 11 × 11 ft. It contains four wells which are 12 ft deep. In each well, a steel rod rides up and down on a chain-drive mechanism. The four rods house at either end, and 6 ft apart, a 300 Cs^{137} source in the International standard source container. The sources are stored, when not in use, in the wells. Controls are outside the chamber. The "on" position of the sources locates them at the ends of the columns. The chamber affords a practical means of achieving uniform TBI. The physics involved in preliminary work includes the development of beam shaping devices, determinations of r-output per hour which is maximum at 250 r, and development of lead filters or absorbers to decrease the r-output to desired levels. Studies in dosimetry are in progress, and measurements of absorbed dosage in organs as a whole will be made in phantoms and cadavers.

15364 A TOTAL-BODY IRRADIATOR.

M.Brucer.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3,
99-105 (April, 1961).

A total-body irradiation room has been built with eight Cs^{13}
sources. One 500 c source is near each corner of an 8 ft cubica
room. An open maze, closed only with a gate, allows the patient
and nurse to appear, through mirrors, to be in the same room.
patient is supported in the centre of the 2 × 2 × 6 ft irradiation
volume on a rigid aluminium bed. The exposure rate to the pati
can be changed from 260 to 1.8 r/hr. The exposure rate outside
the room is less than 0.01 mr/hr. Clinical dosimetry is defined
in terms of minutes. Physical dosimetry includes classical, chemical and phantom studies.

15365 DIRECT LIQUID SCINTILLATION COUNTING OF PLASMA AND TISSUES.

E.Gjone, H.G.Vance and D.A.Turner.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 95-7 (July, 1960).

A new simplified and quantitatively reproducible method for
liquid scintillation counting of C^{14} and H^3 in small volumes of plasma is described. Equal volumes of plasma and 5N KOH are
mixed and heated; 0.2 ml of this mixture is dissolved in 18 ml o
30 (v/v) methanol in toluene counting solution.

15366 CRITERIA FOR EVALUATING COLLIMATORS USE
IN "IN VIVO" DISTRIBUTION STUDIES WITH RADIC
ISOTOPES. W.C.Dewey and W.K.Sinclair.

Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 1
(Feb., 1961).

In many practical circumstances involving the localization
radioactive regions in the body, the highest resolution is not
necessarily desirable because of the accompanying reduction in
sensitivity. A compromise must therefore be effected between
resolution and sensitivity. Principles are presented for effecti
this compromise and a figure of merit is defined in order to det
mine which collimator—detector system provides the highest
probability of detecting a radioactive target located inside a reg
with a different concentration of radioactivity. A most importa
factor is the ratio of target-to-nontarget sensitivity which depe
on both the shielding of the detector and the collimator construc
Three different focusing collimators having 91, 19 and 7 holes,
respectively, and two singlebore collimators, 3 and 5 in. in leng
are studied. It is found that the most suitable collimator for
detecting a given target depends on the size of that target. For
example, of the compromises available, a collimator with very
good resolution and low sensitivity is best for small targets, wh
for larger targets a collimator with low resolution and high sen
tivity is best. Two other questions of interest are considered.
First, the distortion in the representation of the target, which v
with target size, is specified in terms of a parameter called
specific resolution. Second, the concentrations of radioactivity
needed for given scintiscanning situations can be calculated by
means of an equation which is derived. An application of the eq
tion to a practical case in brain-tumor scanning is presented.

THE EFFECT ON MAN OF LOW FREQUENCY ELECTRICA
PROCESSES IN THE ATMOSPHERE. See Abstr. 15241

15367 ELECTROMECHANICAL TRANSDUCER FOR VIBR
TACTILE STIMULATION. R.C.Bice.

Rev. sci. Instrum. (USA), Vol. 32, No. 7, 856-7 (July, 1961).

The device described is a modified common earphone. A
weight is attached to the diaphragm so that the case fastened to
skin becomes the vibrating element. The useful frequency response is 2 to 450 c/s for sensitive body areas.

J.R.Ma

15368 INSTRUMENT FOR CUTTING ANIMAL TISSUES IN
SMALL PIECES (< 3 mm^3) WITH PRESERVATION
VIABLE CELLS. A.L.Sims.

J. sci. Instrum. (GB), Vol. 38, No. 10, 406-7 (Oct., 1961).

Cutting is by a continuous scissor-like shearing action and
instrument is self-sharpening. A steel disk with a spiral groove
cut in one face is rotated horizontally below a vertical rectangu
steel plate. Cutting takes place when tissue in a specially shape

ner is pressed by a sliding weight into the groove of the spiral
on rotation is carried against the sharp toothed edge of the
ary rectangular vertical steel plate. The cut pieces in the
groove are removed by a gear wheel in continuous mesh, and
to a catch tray. The size of the pieces cut is governed by
factors; (i) the width and depth of the spiral groove, (ii) the
pressure and (iii) the spacing of the buttress-shaped teeth
the cutting plate edge.

369 A COBALT MACHINE FOR SEMI-ACUTE IRRADIATION OF GROWING PLANTS.

ingleton, A.Caspar and W.S.Flory, Jr.
at. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 47-54
1961).

Co^{60} machine for irradiating growing plants with gamma rays
cribed. The 200 c machine is shielded behind earthern
rs with concrete retaining walls, also a sky-shine shield
epts vertical radiation. The radiation at the control house,
away, is 2 mr/hr. The source is held in place by an
omagnet which is raised and lowered by a windlass in the
ol house by means of a stainless-steel cable. In case of power
e the Co^{60} source drops into the lead container in the centre
field. Either seeds, plants or other biological specimens
e treated. Doses ranging from 7000 r/hr at 20 cm to 1 r/hr
m may be used. A 1 m the dose is 310 r/hr or approximately
for a $23\frac{1}{2}$ hr day. A dose of 1000 r is sufficient for inducing
mutations in plant material. This can be obtained in $23\frac{1}{2}$ hr
ut 3 m from the source.

aring . Speech

370 DETECTION OF COMPLEX SIGNALS AS A FUNCTION OF SIGNAL BANDWIDTH AND DURATION.

Creelman.
oust. Soc. An er., Vol. 33, No. 1, 89-94 (Jan., 1961).

A study is reported which examined the efficiency of human
vers in the detection of a stimulus waveform which is a train
mped sinusoids. The signal duration and degree of damping
pectral bandwidth) were varied, with the energy of the signal
constant. Increased bandwidth is shown to decrease detection
latively long duration signals. A negligible effect of bandwidth
ound for short durations. Detection of an amplitude difference,
nstrast to detection of the presence of weak signal in noise, is
n to be relatively unaffected either by signal duration or band-
over the range of values studied.

371 PITCH SHIFTS OF PERIODIC STIMULI WITH CHANGES IN SOUND LEVEL.

Small, Jr and R.A.Campbell.
oust. Soc. Amer. Vol. 33, No. 8, 1022-7 (Aug., 1961).

Pitch shifts with changes in sound level were investigated for
ypes of stimuli, one whose pitch was hypothesized to be analysed
e basis of "place" and the other whose pitch was presumed to
lated to "periodicity". Eight subjects made alternate mon-
pitch matches with four stimuli; pure-tone, d.c. pulses (both
energy at the fundamental frequency-place pitch), and two
ties of a.c. pulses (with little energy at the fundamental
ency-periodicity pitch). The fundamental in all cases was
ximately 100 c/s. Generally, pitch shifts were small, although
were marked differences in the extent and in the variability
pitch matches as a function of the type of stimulus. Partly
use of large differences between subjects, statistically
ficant shifts were found for only two of the stimuli, one "place"
ne "periodicity" stimulus. These shifts were similar in
tion, with the pitch shifting downward as level is first increased,
upward with a further increase. Although there appears to be
in the data to support duality of pitch analysis, it is possible
all stimuli were perceived on the basis of periodicity. However,
ems difficult to handle pitch shifts with changes in level within
onfines of "periodicity" analysis.

5372 CRITICAL BANDWIDTH AND THE FREQUENCY COORDINATES OF THE BASILAR MEMBRANE.

Greenwood.
coust. Soc. Amer. Vol. 33, No. 10, 1344-56 (Oct., 1961).

Masked audiograms were used to measure critical bandwidth.
ne assumption that critical bands represent equal distances on
asilar membrane and that critical bandwidth increases expon-
lly with distance from the helicotrema, functions were derived which (1) relate critical bandwidth to frequency and to position on the basilar membrane and (2) relate position of maximum amplitude to frequency. The functions are consistent with Békésy's optical observations and Mayer's psychophysical data. The frequency-position function is $f = A(10^{ax}-1)$. The coefficient a is numerically identical with the coefficient in the exponential function fitting Békésy's elasticity data. Functions of this form fit data from seven other species and the values of the coefficient a seem related to their respective elasticity functions. The interpretation of critical bandwidth as the frequency interval over which the cochlea sums power is supported by data of Mayer, and the hypothesis that critical bands represent equal distances on the basilar membrane is strengthened, one critical band corresponding to one millimetre. Problems for cochlear theory are posed (1) by the apparent equivalence of critical bandwidth, the derivative of the frequency-position function, and the frequency interval over which spatial integration takes place, and (2) by the proportionality of these three at a given point to the compliance at that point.

15373 PERCEPTION OF SOUNDS CHARACTERIZED BY A RAPIDLY CHANGING RESONANT FREQUENCY.

P.T.Brady, A.S.House and K.N.Stevens.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1357-62 (Oct., 1961).

The perception of sounds characterized by a moving resonance was investigated in a series of experiments. Stimuli were generated by exciting a tuned circuit with a short train of pulses of repetition rate 100 sec^{-1}. The resonant frequency of the tuned circuit was changed in a piecewise-linear manner over a 500 c/s range. Subjects matched the test stimuli by adjusting the resonant frequency of a fixed (i.e. nonvarying in time) resonant circuit until the test and comparison stimuli were judged to be most alike. Results indicate a strong tendency for subjects to adjust the frequency of the fixed resonant circuit until it is close to the terminal resonant frequency of the time-varying circuit. This tendency depended to some extent on the direction and rate of the frequency change in the test stimulus. The implications of the results for auditory theory and speech perception are discussed briefly.

15374 FURTHER INVESTIGATION OF THE EFFECTS OF INTENSITY UPON THE PITCH OF PURE TONES.

A.Cohen.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1363-76 (Oct., 1961).

Typical methods for observing pitch changes with intensity for pure tones consist of varying the frequency of one tone of fixed intensity (the comparison tone) so as to match the pitch of a second tone of fixed frequency (the tone under test) when the latter is set at different intensities. Differences between the comparison and test-tone frequencies, when equated in pitch under these conditions, are ascribed to their intensity differences and used as a measure of the pitch—intensity shifts for the test tone. The comparison and test tones may differ in frequency, however, even when they are matched in pitch under equal intensity conditions. These frequency differences, called pitch-matching errors, may be identical to those noted above for comparable conditions and consequently nullify the apparent pitch—intensity shifts. This possibility was studied in two experiments which sought to reproduce the pitch—intensity relationship as defined by the data of Stevens (1935) and Snow (1936). In more than half the comparisons made under various frequency and intensity conditions, apparent pitch shifts for 50, 75, 100, 200, 400, 700, 1500, and 6000 c/s were found to be not significantly different from pitch-matching errors. When averaged, the remaining shifts followed the directions of Stevens' curves but were small (2% or less). Pitch—intensity functions for the lower frequency tones were particularly variable and generally bore little relationship to Snow's functions for such tones.

15375 SENSITIVITY OF THE WATER-IMMERSED EAR TO HIGH- AND LOW-LEVEL TONES.

W.E.Montague and J.F.Strickland.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1376-81 (Oct., 1961).

Two experiments are reported regarding man's sensitivity to waterborne sound. The first study investigated the threshold sensitivity to tones of 250, 500, 1000, 1500, 2000, 3000, 4000, and 6000 c/s and the attenuation due to the diver's hood. The second experiment obtained data on the "tolerance" to a high-intensity tone of 1500 c/s. The sound-pressure level needed to reach threshold in water is about 40-70 dB higher than the MAP threshold in air. The greatest loss in sensitivity occurs in the regions of greatest air sensitivity. The diver's hood was found to provide about 20 dB or more of attenuation of underwater sound at frequencies above 1000 c/s. The "tolerance" limits for hoodless divers is approximately 174 dB re 0.0002 dyne/cm^2. When wearing the hood divers were able to tolerate at least 180 dB, the system's maximum output. Above 165 dB all divers reported some distortion of the visual field.

15376 AUDITORY THRESHOLD SHIFTS PRODUCED BY SIMULTANEOUSLY PULSED CONTRALATERAL STIMULI.

C.E.Sherrick, Jr and P.L.Mangabeira-Albernaz.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1381-5 (Oct., 1961).

Evidence from studies of tactual sensitivity indicates that transient suprathreshold stimuli presented simultaneously with and contralateral to test signals will mask such signals more effectively than do steady stimuli. The present report presents evidence that when pulsed masking sounds are presented simultaneously with pulsed auditory signals, two major effects are observed: First, a significantly greater amount of contralateral masking is obtained with the pulsed masker than with the steady masker, and, second, the pulsed masker is more effective in the monaural condition also. Furthermore, the masking effect of pulsed maskers increases with the increase of signal frequency, but not with increase of masker intensity. The frequency of the masker must be near that of the signal to be effective, and if pure-tone maskers are used with pure-tone signals, the masking effect shifts continuously to the localization effect as the signal frequency approaches the masker frequency. Some explanations of binaural and contralateral masking are discussed.

15377 RECOGNITION OF SPEECH BY A COMPUTER PROGRAM THAT WAS WRITTEN TO SIMULATE A MODEL FOR HUMAN VISUAL PATTERN PERCEPTION.

L.Uhr and C.Vossler.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1426 (Oct., 1961).

A computer simulation programme for visual "pattern recognition" was tested on an array of extremely degraded spoken digits. The programme develops its own set of operators, as a function of its experience with inputs presented to it; so it does not depend upon preanalysis of a specific problem. The programme gave (on an array of five different numbers) 100% success on words that had been presented to it for "training" purposes, and 100% success on words spoken by speakers different from those used in training. Results with alphabetical patterns, in which 5, 10 and 26 letter arrays were all learned to 100% success, suggest that larger arrays of spoken words may give similar results.

Vision

15378 THE ABSOLUTE LIMIT IMPOSED BY QUANTUM FLUCTUATIONS AT THE DIFFERENTIAL THRESHOLD OF LUMINANCE. R.Crouzy.

C.R. Acad. Sci. (France), Vol. 253, No. 3, 559-61 (July 17, 1961).
In French.

The discontinuous structure of radiation sets a limit to the sensitivity of all detectors, and Rose has applied the theory to human vision. The conditions under which his theory is valid are examined and measurements of differential threshold are quoted to show that the human eye effectively attains the limiting sensitivity predicted by this theory. R.W.Fish

15379 NOTES ON THE PHOTOMETRIC SIGNIFICANCE OF THE HUMAN CRYSTALLINE LENS. R.A.Weale.

Vision Res. (GB), Vol. 1, No. 1-2, 183-91 (June, 1961).

The effective pathlength of the human crystalline lens is calculated as a function of aperture and its photometric effects examined on the assumption that the distribution of yellow pigment is uniform. The data are applied to the interpretation of the age variation of the absolute visual threshold and to the spectral variation of the Stiles—Crawford effect.

15380 RELATIVE VISUAL LATENCY AS A FUNCTION OF RETINAL LOCUS.

M.Lichtenstein and C.T.White.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1033-4 (Sept., 1961).

The subject was required to tap with his finger in synchronism with a flashing light positioned at a particular point in the visual field. The lag of the tap behind the flash to which it was synchronized gave the subject's latency. Experiments carried out on two subjects for 49 different loci in the visual field showed, inter a
that the latency increased with distance from the fovea and that
the latency could be related quantitatively to the rod and cone
densities. E.A.M

15381 LOCUS OF HYPNOTICALLY INDUCED CHANGES COLOR VISION RESPONSES.

I.Goldiamond and L.F.Malpass.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1117-21 (Oct., 1961).

A modification of the Bidwell apparatus was used to invest
whether colour responses altered by hypnotic instructions had
sensory or a report locus. This apparatus produces colours w
are either complementary to or are enhanced positives of colo
inserted. Hypnotized subjects were shown colours which they
told would be presented and were asked to report what they sav
Responses were recorded to gray and coloured presentations.
results obtained could be parsimoniously explained only by ass
ing a report locus to the altered responses of these subjects as
well as to those of a subject for whom hypnotic instructions se
to have induced colour blindness.

15382 ON THE BEZOLD-BRÜCKE PHENOMENON.

P.L.Walraven.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1113-16 (Oct., 1961).

An explanation of the phenomenon is given in the framewo
of the Young—Helmholtz theory. It is assumed that the respon
of the three independent receptor systems gradually increase t
end value with increasing stimulation. The sensitivity curves
the three systems are assumed to be those derived by Pitt. To
account for the law of additivity of brightness it is necessary t
make a distinction between a brightness information and a chr
ness information channel. The nonlinear relationship between
response and stimulation of the several systems has to be appl
in the latter channel. For wavelengths at the crossing points o
Pitt's curves no hue change can be expected. This explains the
invariable hue at 570 mμ. To account for the invariable hue at
476 mμ it is necessary to assume that the contribution of the b
system to chromaticness, its chromaticness valency, is about
10 times its brightness contribution. The third invariable hue
508 Mμ has to be considered as the hue at which the tendencies
the greens to shift toward yellow and toward blue are in balanc
The theory is in accordance with the results of some measure
done in the purple region of the colour diagram, where an inva
hue was also found.

15383 SPECTRAL SENSITIVITY OF SINGLE NEURAL UN IN THE BULLFROG RETINA. R.M.Chapman.

J. Opt. Soc. Amer., Vol. 51, No. 10, 1102-12 (Oct., 1961).

Nerve impulses from retinal units, presumably ganglion c
were elicted by calibrated light flashes of various luminances,
lengths, and durations, delivered to the eye of the intact bullfr
under scotopic and photopic conditions. Although several resp
measures were utilized, latency to the first impulse was partic
useful. A simple linear function relating reciprocal of latency
log light luminance was associated with the dark-adapted state
more complex latency-luminance functions were associated wi
light-adapted state. Spectral sensitivity curves were derived
these latency-luminance functions by determining the relative
energy at the various wavelengths required to produce a criter
latency. A wide variety of relative spectral-sensitivity curves
found. The average shift of spectral sensitivity toward the lon
wavelengths (Purkinje shift) between scotopic and photopic conditions was in approximate quantitative agreement with a shift
the rhodopsin to the iodopsin absorption spectrum. The Purki
shift was also seen in the results obtained from some individu
neural units. Among the variety of spectral sensitivity curves
obtained from the 20 dark-adapted units, a homogeneous group
curves (11 units) was identified which was well fitted by the rh
sin absorption curve. Of the 16 light-adapted units, one group
units) was roughly fitted by the iodopsin curve. Of special inte
to colour theory are the units not included in the rhodopsin or
iodopsin groups. While none of the curves were completely fit
by Granit's modulators, many of the sensitivity peaks were at
lengths that correspond to his green and red modulators (frog).
Relatively narrow spectral-sensitivity curves with maxima bel
450 mμ were obtained from several of the dark-adapted units;
these were reliably different from Granit's blue modulator (fr
and were approximately fitted by Dartnall's blue-sensitive pig

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Vol. 64 (1961). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d, post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Biul. Inst. Energetkyi (Poland)	Biuletyn Instytutu Energetiki [Published as inset in Energetyka].
Bull. Amer. Ceram. Soc.	Bulletin of the American Ceramic Society 4055 North High Street, Columbus 14, Ohio.
Bull. Seismol. Soc. Amer.	Bulletin of the Seismological Society of America 465 California Street, San Francisco 4, California.
Corrosion (USA)	Corrosion [Abstracted by Associated Electrical Industries, Manchester].
Cryogenics (GB)	Cryogenics Heywood & Co., Carlton House, Great Queen Street, London, W.C.2.
Czech. heavy Industr.	Czechoslovak Heavy Industry [Abstracted by Associated Electrical Industries, Manchester].
Diesel Railway Traction (GB)	Diesel Railway Traction [Abstracted by Associated Electrical Industries, Manchester].
Engng Materials and Design (GB)	Engineering Materials and Design [Abstracted by Associated Electrical Industries, Manchester].
Exper. Stress Anal. (USA)	Experimental Stress Analysis [Abstracted by Associated Electrical Industries, Manchester].
Iron and Steel (GB)	Iron and Steel [Abstracted by Associated Electrical Industries, Manchester].
Iron and Steel Engr (GB)	Iron and Steel Engineer [Abstracted by Associated Electrical Industries, Manchester].
J. Amer. Ceram. Soc.	Journal of the American Ceramic Society 4055 North High Street, Columbus 14, Ohio.
Petrol. Times (GB)	Petroleum Times [Abstracted by Associated Electrical Industries, Manchester].
Phys. Status solidi (Germany)	Physica Status Solidi Publication address: Akademie-Verlag, Leipziger Strasse 3-4, Berlin, W.8.
Polymer (GB)	Polymer [Abstracted by Associated Electrical Industries, Manchester].
Publ. Elektroteh. Fak. Univ. Beogradu, Ser: Telekom. Elektron. (Yugoslavia).	Publikacije Elektrotechničkog Fakulteta Univerziteta u Beogradu, Serija: Telekomunikacije i Elektronika. [Publications de la Faculté d'Electrotechnique de l'Université á Belgrade. Série: Télécommunications et Electronique]. University of Belgrade.
Railway Gaz. (GB)	Railway Gazette [Abstracted by Associated Electrical Industries, Manchester].
SPE J. (USA)	SPE Journal [Abstracted by Electrical Research Association].
Trudy Inst. Energetiki i Elektrotekh. Akad. Nauk Latv. SSR	Trudy̆ Instituta Énergetiki i Élektrotekhniki, Akademiya Nauk Latviĭskoĭ SSR Publication address: Akademiya Nauk Latviiskoi SSR, Riga.
Wald. J. (GB)	Welding Journal [Abstracted by Associated Electrical Industries, Manchester].

ERRATA

Abstr. 8570 (1960) line 1: for "Feyman" read "Feynman".
Abstr. 10229 (1960) line 3: for "M.Wager" read "M.Weger".
Abstr. 11210 (1960) line 3: for "V.M.Vishnyakov" read "V.V.Vishnyakov".
Abstr. 13713 (1960) line 5: for "Z.A.Trapezhikova" read "Z.A.Trapeznikova".
Abstr. 14805 (1960) line 3: for "M.Neves E.Castro" read "M.Neves e Castro".
Abstr. 15479 (1960) line 1: for "CURTAIN" read "CERTAIN".
Abstr. 19830 (1960) line 2: for "ACCELATOR" read "ACCELERATOR".
Abstr. 19847 (1960) line 2: for "SYNCHROTON" read "SYNCHROTRON".
Abstr. 19855 (1960) line 2: for "CYNCHRO-CYCLOTRON" read "SYNCHRO-CYCLOTRON".
Abstr. 20378 (1960) line 1: for "IRRIATION" read "IRRADIATION".
Abstr. 21324 (1960) line 3: for "TROPOSHERE" read "TROPOSPHERE".
October (1960) p. 1449, col. 2: for abstract number "134654" read "14654".
Abstr. 10980 (1961) line 1: for "BREMMSTRAHLUNG" read "BREMSSTRAHLUNG".
Abstr. 11679 (1961) line 2: for "B.J.Bray" read "R.J.Bray".

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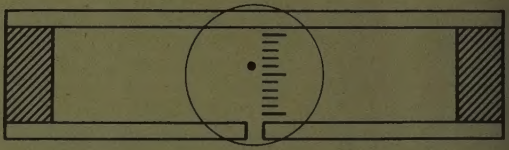

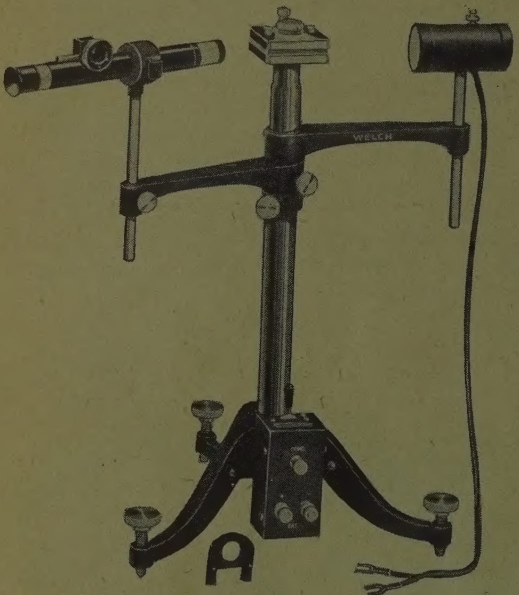

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